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CONTENTS

The Structure of the Universe: DR. J. C. KAPTEYN 717

Blood Parasites: DR. HENRY GEORGE PLUMMER 724

Some Educational Problems in Kansas: CHANCELLOR FRANK STRONG 730

The American Society of Naturalists: DR. BRADLEY M. DAVIS 734

The American Psychological Association: PROFESSOR W. V. BINGHAM 735

The Dana Centenary 736

Scientific Notes and News 736

University and Educational News 740

Discussion and Correspondence:—

Atomic Ionization and Atomic Charges: PROFESSOR FERNANDO SANFORD. 741

Scientific Books:—

The Maryland Devonian Books: DR. JOHN M. CLARKE. *White's Technical Gas and Fuel Analysis:* PROFESSOR R. P. ANDERSON. 742

Professor Noguchi's Researches on Infective Diseases: SIR STEPHEN PAGET 746

Diatom Collection of the United States National Museum: DR. FREDERICK V. COVILLE. 748

Special Articles:—

Reversibility in Artificial Parthenogenesis: PROFESSOR JACQUES LOEB 749

Societies and Academies:—

The Biological Society of Washington: D. E. LANTZ. *The Anthropological Society of Washington:* DANIEL FOLKMAR 751

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THE STRUCTURE OF THE UNIVERSE[1]

I HAVE been asked to address you on the structure of the universe. The title is ambitious, and I fear that what I have to say on the subject will be sadly in disproportion with what some of you will be led to expect by this title.

It will, however, I hope, give you a glimpse of what astronomers now-a-days are attempting to do, in order to penetrate somewhat into the mystery of the starry sky.

The problem, as I take it, is a double one. We have, first, the structure of the universe as it is at the present moment; and this problem is, in the main, no other than finding the star distances, because the star directions we can readily ascertain.

We have, second, the problem of the history and evolution of the system.

The time at my disposal being so short, I must confine myself to one of the two. At the present moment, undoubtedly, the first is the more promising one, owing to the recent discovery of star-streaming. Furthermore the history of the system during the past ages, ages to be counted by millions, probably hundreds of millions of years, is and perhaps forever will remain enshrouded in much mystery. Still I have thought that the second problem, that of the evolution of the system, may, perhaps, be the more suitable subject for the present lecture.

You will all, of course, understand, without my saying anything to the purpose, that what we have to expect can not well be anything else than a few more or less

[1] Address delivered before the National Academy of Sciences, April, 1913.

probable inferences about the course of events that have made our system what it is.

Some additional considerations might easily have been added, but as I have had to give up the idea of giving a general review of what has been done, I thought it might be as well to confine myself to just a few illustrations of the kind of speculations that we are being at present led to; and as these speculations, mainly or wholly, depend on the theory of star-streaming, it may be well to begin by saying a few words about that theory.

In order to get a clear idea of what is understood by the phenomenon of star-streaming: Imagine two clouds or swarms of stars, at first wide apart in space; imagine that the stars within each cloud move in all directions, indiscriminately, pretty much as do the molecules of a gas, and let us call this motion in the cloud the "internal motion." In fact, imagine two immense gas bubbles, the molecules of which will be our stars.

Now, imagine these two clouds or bubbles to be moving in space, and let that motion bring the two gas bubbles together, so that they will penetrate each other. Then imagine that we, the spectators, are in that part of the universe where the two bubbles have intermixed, and finally imagine that we, the spectators, have a motion of our own.

What we shall see of the motion of the individual gas molecules will very nearly correspond to what we see of the motion of the stars actually going on in the sky.

Now, what is the appearance of such a motion? Had the molecules in each gas bubble no internal motion, that is, had they no other motion than the common cloud-motion of all the molecules together, as a whole, then of course what we would see would be this: We would see two immense streams of stars, all moving in perfectly parallel lines, with what, linearly, must be perfectly equal velocity.[1] If, however, the internal motion is not zero, then, of course, what we shall see will be more or less different. The internal motion gives to each molecule, besides the motion which is common to the whole of the bubble, an additional individual motion, which will make the total motion of the several molecules diverge more or less from perfect parallelism and perfect equality. Instead of seeing two streams with perfectly parallel motions, we must now see the stars *in the main* parallel to two directions, but there will be deviations—small deviations will be frequent, greater deviations will be rare, and very great deviations will be decidedly exceptional. The motion of the two individual bubbles will still be clearly discernible.

Now this is indeed what we observe in the sky. We recognize in the star motions two clearly defined *preferential* motions. These directions make an angle of about one hundred degrees. The stars are not moving all in these directions. Small deviations are frequent; greater deviations are somewhat rare; very great deviations are decidedly exceptional.

We may say that all investigations made since the first announcement of star-streaming in 1904—investigations based on very different materials—all agree in the establishment of these two preferential directions of motion among the stars. We find them in the brighter stars; we find them in the fainter stars; they show in the swift-moving stars; they show in the slow-moving stars. They betray their existence in the radial motions as well as in the motion at right angles to the visual ray.

In the *interpretation* of the facts, how-

[1] Throughout the address the motions are to be understood as relative to the sun.

ever, there is a difference. *Our* representation by the two independent star clouds is one of them. Whether this interpretation is the correct one, is a question of evolution of the system and will have to be considered presently.

Our conclusion will then be in favor of the two-cloud theory; and so, for the sake of greater clearness, I will provisionally continue to use this representation. In reality what will be advanced will not be changed, or but slightly, if we simply start from the observed facts.

In the study of the history of the system, we start from what we know, or think we know, about the evolution of the separate stars.

The stars have been classified by Secchi into four spectral classes. We have at present far more elaborate classifications, but for the present purpose Secchi's classification will do. The stars of the fourth type are so few in number that we may, for the present, neglect them. Part of the first type has later on been separated from the rest; they show the helium lines in their spectrum and are now generally brought to a separate class, the class of the helium stars.

We will thus consider the four classes: the helium stars, those of the first, second and third types—helium, first, second and third—in which the bulk of all the stars with known spectrum are contained.

Now, there is much evidence to show that this classification is a natural one. I mean that this order is really an order of evolution; the helium stars being the stars of recent birth; while we get to older and older stars as we pass from the helium stars to the first, from the first to the second, and from the second to the third type. I will adopt this order of evolution in what follows, although well aware of the fact that all astronomers do not agree with me. I feel justified in this course, not only because I think it is the opinion of the great majority of our eminent spectroscopists, but also because the very facts which I wish to put before you about star streaming strongly confirm it.

When we wish to penetrate into the history of the system, it seems natural to investigate the problem of star streaming separately for those four classes of stars in the order of their evolution. There are some difficulties, mainly the consequence of scantiness of material. Still, however, even now it has been possible to carry the investigation through in such a way as to establish a couple of facts, and to give clear indications of others. Of these I will consider only the two following, about the reality of which I think there can hardly be left any doubt.

First, the older the stars, the greater the internal velocity, and

Second, the older the stars, the richer the second stream, at least in comparison with the first stream.

I wish to consider some of the inferences to which these facts lead us. And in the first place, these facts at once lead us back to the question just now mentioned, about the order of evolution of the individual stars. For this regularity in the increase both of the internal velocity and of the richness of the second stream exist only *if we adopt* for the order of evolution either the order, helium, first, second and third, or the exact verse order, third, second, first, helium, and in no other arrangement.

Therefore, with the same right that we expect that all the properties of the stars will change with age, gradually, and not per saltum, with that same right, I think, we conclude that the order of evolution must be helium, first, second, third, or the exact reverse. That it is not just the reverse is proved by other facts we can not now consider.

We thus have strong confirmation here of what, on totally different grounds, is pretty generally considered as the order of the different ages in a star's life.

But to proceed: As the younger the stars, the smaller their internal motion, it follows at once that from whatever matter our youngest stars—the helium stars—may have been evolved, that matter must, in all probability, have still smaller internal motion. Let us call this matter *primordial matter*. As the internal velocity of the helium stars is already so very small we come to the conclusion that primordial matter must practically have hardly any other motion than the motion of the cloud to which it belongs.

There is more. According to the second of the observed facts, the second stream, which is rich for the older stars, is much poorer for the younger ones; it almost dies out in the helium type stars. We must expect, therefore, that for primordial matter there will practically be no second stream or second star cloud.

Therefore, finally, we must expect that the particles of primordial matter will all move in practically parallel lines, and that in the direction in which all but a very few of the helium stars move, and with the same velocity.

Now it is a very general notion that it is from the nebulæ that the stars are formed. Therefore that what we called primordial matter would be nothing else than the matter of the nebulæ. What precedes gives us the means of testing the notion by observation. What then does observation show?

The number of available data is as yet extremely small. The determination of what we call astronomical proper motion of these very ill-defined objects is extremely difficult, and has been up to the present time invariably unsuccessful. For the determination of the radial velocity by the spectroscope, the faintness of the nebulæ is a serious obstacle. The consequence is that, as yet, we know the radial velocity of only fourteen of these objects in all. Still, even this limited number is decisive in showing that there can be no question that the real motions of these objects are approximately parallel to the motion of the helium stars, or even parallel to any fixed direction whatever. Their velocity, moreover, is exceedingly unequal. Must we conclude that the nebulæ are not the birthplace of the stars? It may seem so.

Meanwhile let us not go too fast. There are nebulæ and nebulæ. It so happens—and there is ample practical reason for it—that with one exception observation of radial velocity has, up to the present time, been confined to what we call the planetary nebulæ—elliptical or round nebulæ—which show an appearance remotely like that of a planetary disc. Herschel saw in them a likeness to what, according to Laplace's cosmogony, must have been the primitive stage of our own planetary system and so imagined that these planetary nebulæ must be the birthplace of the stars.

According to what precedes, this view seems now untenable. The planetary nebulæ can not be the birthplace of the stars. If they were, they would show the parallel and equal motion of practically all the helium stars. Their motions, on the contrary, are extremely unparallel and unequal, and we must rather assign these objects a place at the end of the order of evolution than at the beginning.

We may, perhaps, see an independent confirmation of this view in the stars called temporary stars, but time will not permit me to pursue the argument further.

As I said just now, there is one nebula for which the radial velocity has been determined which is *not* a planetary. This

exception is the well-known Orion nebula, which is classified under the irregular nebulæ. May not then these irregular nebulæ give birth to the stars?

It turns out that this one object has exactly the radial velocity of the first stream helium stars; that is, we find exactly the motion we must expect in this nebula, if it were the birthplace of stars. We shall not, of course, on this single fact base far-reaching conclusions; but we have a right, in my opinion, to say that here is a fact that singularly strengthens what had already been concluded from other facts.

We see, moreover, that the observation of the radial velocity of other irregular nebulæ must, ere long, furnish us with a crucial test of the theory.

There is another problem involved in our observations which might seem to be of no less importance than the one just mentioned. How have we to explain the fact that the internal velocity of the stars gradually increases with age? The astronomer who, in the study of the motion of the heavenly bodies, has found hardly a trace of any other force than gravitation will naturally turn to gravitation for such an explanation. It really seems a necessity that, under the influence of their mutual gravitation, bodies, which at the outset have little or no relative motion, must get such a motion; they must come to fall toward each other, and this velocity, up to a certain limit at least, must increase with time.

Thus far, there is no great difficulty. But now let us look farther back in time, back to the time in which the stars had not yet been formed, in which matter was still in its primordial state. If it be true that mutual attraction of the stars has generated such an enormous amount of internal motion in the time needed by the stars to develop from the helium type to the second and third type, how have we to explain the fact that we find that same matter nearly at rest at the first stage of evolution at which we meet it? How have we to explain that in pre-helium ages gravitation has produced no effect?

He who believes in the creation of matter at a finitely remote epoch may find no difficulty in the question; but to him who does not, it is simply astonishing to see matter behaving as if there were no gravitation at all. What may be the explanation? Is there no gravitation in primordial matter, or is there another force exactly counterbalancing its effects?

I shall offer no solution. I simply wish to point out that here is a problem which must be interesting to the physicist no less than to the astronomer.

Passing now to other inferences, I wish to draw your attention to a question already alluded to: does the observed fact of the preference of the star motions for two definite directions lead us with necessity to the assumption that our system has been formed by the meeting of two independent star clouds? Or is it still possible, and in that case more plausible, to explain it without sacrificing the unity of the system? In other words, is our universe a dual system, or is it one unit?

Suppose[2] a very elongated system of stars which are originally at rest; now let these be left to their mutual attraction. It is evident that the stars, in opposite parts of the cloud, will begin to fall towards each other. Two streams will be set up, opposite in direction, approximately parallel to the axis of the cloud, though in no wise absolutely and exclusively so. In other words, we get two preferential directions of motion. There is no real difficulty in the fact

[2] The following supposition was first considered in a lecture held at Harlem in 1906 ("Programme de la Soc. Holl. des Sc. pour 1906," p. liv).

that they are exactly opposite, whereas the streams observed in the sky make an angle of about a hundred degrees. For opposite streams, viewed from a self-moving body, as in our earth, will appear to make an angle and we can readily determine the earth's motion in such a way as to bring us in perfect harmony with observation. Thus far no objection. But there are further consequences.

In an elongated universe, as here supposed, *both* the mean longitudinal motion (what in this lecture was called the stream motion) and the deviations therefrom (the internal motion) must gradually increase, beginning with velocity *zero*.

Now as to the internal velocities, this is exactly what we find by observation. Do we find the same for the stream motion? By no means.

Recent Mt. Wilson observations have enabled us to derive at least a pretty reliable value of the relative stream velocity for the first type stars. For the helium stars we can as yet only assign a limit which the relative velocity of the two streams must exceed. For the older stars we have had reliable information for some time.

All these determinations show, contrary to what takes place with the internal motion, that the relative velocity of the two streams or clouds does not change, or does not change very much, with age. It certainly is not nearly vanishing for the helium stars. It seems to me that this consideration is fatal to the present explanation.

Professor Schwarzschild has developed a different theory, which also leaves the universe a unit; but this theory too, elegant though it be, can not, I think, be maintained. Among other things, we have, as a main objection, the fact—which was not known at the time Professor Schwarzschild proposed his theory—that the richness of the two streams is not the same for stars of different age. The tacit assumption is made, and must be made, in Schwarzschild's theory, that the two streams have the same number of stars. Now, this may be more or less approximately true of the stars of the second and third types, for the first type the number of stars in the second stream can not be much different from *one third* of that in the first stream. For the helium stars it must not be a *tenth*. The second stream is so poor here that it has been altogether overlooked till quite recently.

The conclusion to be drawn from all this seems obvious. It would seem that we are driven to the theory assumed here, from the first, the theory of the two-star clouds, which, owing to their initial velocity, have come to meet and intermingle in space. It must be confessed, however, that in this theory also there remain some hard nuts to crack. Until we succeed in this it seems unsafe to claim any great certainty for the theory, and it seems preferable to put it forward as the hypothesis which, for the time being, best fits the observed facts.

There remains to be considered the question how to explain that the second stream or cloud hardly contains any helium stars.

There is something in the small local star-groups which may help us. Everybody knows the group of the Pleiades. There can be no doubt that the bright and many of the faint stars that we see in this part of the sky are really near together in space and not merely near the same visual line, the one far behind the other. They undoubtedly form a physical system, and must have had a common origin. At present we know several of such local groups, among them the Hyades, the Ursa Major group, and we may perhaps add the great Scorpius-Centaur group.

Now, in these local groups, we find,

amongst others, two very remarkable facts. The first is that, ignoring a few, though significant exceptions, if the stars of such groups are arranged in the order of their brightness, we find that they are at the same time approximately arranged in the order of the spectral classes. As an instance, take the Scorpius-Centaur group. We find that the very brightest stars are of the earliest helium type; the somewhat fainter ones are of the older helium type; the next fainter ones are of the next stage in the stellar life, or the first type. If we can not follow the series further on to the second and perhaps the third type, this is probably due to our lack of knowledge of the fainter stars belonging to the group. In the Pleiades, where we have a somewhat more extensive knowledge of the fainter stars, we can follow the series at least until in the middle of the second type stars. It follows from this that in all these groups, what there is of helium stars can not be overlooked, for they all are of the very brightest stars, and our knowledge of the brightest stars is pretty complete.

Notwithstanding this—and this is the second remarkable fact, the fact that bears directly on the question in hand—we find not a single helium star, neither in the Hyades nor in the Ursa Major group. The stars in these groups show the same gradual change of spectrum with the brightness, but instead of beginning with the earliest helium stars, the series begins abruptly with the second stages of a star's life. In the Pleiades the series begins somewhat earlier; still here too there is not a single star of the earliest helium type. It is only in the Scorpius-Centaur group that we find the complete series.

Our second stream, therefore, behaves much as do the local groups of the Hyades and Ursa Major. The explanation must, in all likelihood, be the same in both cases.

How, therefore, does it come to pass that in such groups as those of the Hyades and the Ursa Major, the helium stars are absolutely wanting?

For those who, as I did in this lecture, adopt the view of the order of evolution as helium, first, second, third type, there can be no question but that the stars which we now see are first type stars, must in past ages have been helium stars.

Therefore, such a group as the Hyades, which now-a-days does not contain any helium stars, but which contains first type stars, must in past ages have contained the helium stars in great numbers. Going back in time still further, these helium stars must have been evolved from some primordial matter, probably some nebulous matter. Therefore, in a remote past the groups of the Hyades and Ursa Major must have been full of nebula. As far as I know there is no trace of nebulosity now.

There thus must have been an epoch in the past that nebulous matter was exhausted, had probably all gone into the formation of stars. Since that time evidently there could be formed no more helium stars; and as the helium stars that had been formed developed gradually into first type stars we see the necessity of a time in which the groups must not contain any more helium stars.

Therefore, finally, our answer to the question: how does it come to pass that in the second stream or cloud we find hardly any helium stars, would be: because since some time nebulous matter must have been exhausted in this cloud.

As to the first stream or star cloud, we similarly conclude that the nebulous matter must not yet have been exhausted, or if so, only at a very recent period.

It has been my aim to show, *not* that much has been done, but that there is a beginning; *not* that we have entered far into

the promised land, the land lying open to the human view, so temptingly since the first man looked up to the sky, but that a few pathways are being mapped out, along which we may direct a hopeful attack. Our problems take a more definite form, and even though we were never to solve them completely, let us remember the words of the poet:

> If God held in His right hand all truth, and in His left nothing but the ever ardent desire for truth, even with the condition that I should err forever, and bade me choose, I would bow down to his left, saying, "Oh, Father, give; pure truth can be but for Thee alone."

J. C. Kapteyn

BLOOD PARASITES[1]

You will remember that Mephistopheles, when he insists upon the bond with Faust being signed with blood, says, "Blut ist ein ganz besondrer Saft" (Blood is a quite special kind of juice). Goethe would probably not have used the word "Saft" had he been writing "Faust" to-day instead of in 1808, for at that time the cellular elements of the blood—although they had been seen and described by Leeuwenhoek in 1686—were believed to be optical illusions, even by so distinguished a person as the professor of medicine of that time at the Sorbonne. The incredulity of scientific men as to what they see is proverbial and astounding, fortunately; but it is probably because science is really quite sure of nothing that it is always advancing.

I have the privilege this evening of trying to show you the barest outlines of our present knowledge of the parasitology of the blood. It is a subject of great practical and economic importance, as many grave diseases of man and beast are caused by these parasites, which, on account of their minuteness, enormous numbers and very complex life-histories, are very difficult to eradicate or to deal with practically. On this account there is a good deal of the enthusiasm of the market-place mixed up with this subject, which, although a new one, has advanced with great rapidity, and has revolutionized pathology and medicine as far as possible. From our point of view it began in 1880 with the discovery by Laveran, in the military hospital of Constantine, of the parasite which causes malaria. This caused the protozoa, to which order most of these parasites belong, to oust bacteria from the proud position they then occupied of being the cause of all the ills we have to bear, and to reign in their stead; not an altogether desirable change; for when you have seen what I shall show you, you will agree with me that sufficient unto life is the evil thereof. It has had all the disadvantages of a new subject, and since that time floods of work have been poured into journals, annals, proceedings, etc., some of it of the best, with much of it that is indifferent, temporary and bad; so that at times it seems as if this branch of science were in danger of being smothered in the dust of its own workshop, or drowned in the waters of its own activity. We do not, nowadays, keep our ideas and scraps of work to ourselves until they are either established, or, as is more likely, dissipated, so we have a huge mass of what is called "literature," filled with many trivial, fragmentary and doubtful generalizations, many of which we have with pain and trouble to sweep into the dustbin: nature's blessed mortmain law taking too long to act. You remember Carlyle complained—to use a mild term—of Poggendorff's "Annalen," and I feel sure that, if he had had to study blood parasites now, he would have said that it was a much over-be-Poggendorffed subject. Blood parasites are afflicted, too, with ter-

[1] Abstract of a lecture before the Royal Institution of Great Britain, May 2, 1913.

rible names, and with large numbers of them; some have as many as ten or even fifteen different names, perhaps on the Socratic principle, that naming saves so much thinking. And they are in Latin, too, so that the terminology of this subject is a perfect museum of long Latin and hybrid-Latin names. The terminology generally of our later biology is, as one has said, "the Scylla's cave which men of science are preparing for themselves, to be able to pounce out upon us from it, and into which we can not enter." This will be my excuse if I should use words you do not understand.

I will just remind you of the structure of the blood, that it consists of an extraordinarily complex fluid—the plasma—which holds in suspension living cellular bodies, called cells or corpuscles. These are of two kinds, red and white corpuscles. The red are by far the more numerous, and in man there are about 5,000,000 of them to a cubic millimeter of blood, but this number varies enormously under the influence of parasites. To these red corpuscles is due the red color of the blood, and they are the carriers of oxygen, acquired by the aeration of the blood in the lungs, to the tissues. We breathe in order that they may breathe, for we only care about oxygen in so far as they care about it.

The other kind of corpuscles are the white, or leucocytes, and of these, in health, there are about 7,500 per cubic millimeter. A few years ago it was enough to know that there were red and white corpuscles, but now we have to know more. Through the work of Ehrlich we know that there are at least five different kinds of leucocytes in normal blood, which I will just indicate to you.

1. *Lymphocytes.*—These are the smallest cells, and contain a relatively very large nucleus.

2. *Large Mononuclears.*—These are large, and are called macrophages, as they possess the power of being able to absorb and digest parasites and other foreign bodies.

3. *Polynuclears.*—These are characterized by the irregular, moniliform aspect of their nucleus, and they are called microphages for the same reason that the large mononuclears are called macrophages. Both of these are also called, generally, phagocytes, on account of their power of ingesting and digesting foreign bodies.

4. *Eosinophiles.*—These are characterized by a bilobed nucleus, and by granulations which color deeply with eosin and other acid colors.

5. *Labrocytes or Mastzellen.*—These are rare, and are characterized by large granulations which stain with basic colors.

In parasitic diseases these corpuscles are profoundly modified and altered, numerically and morphologically, and other new elements may make their appearance in the blood.

The blood is essentially the same in all animals, but it varies within certain limits. For instance, the red corpuscles are not of the same size and shape in every animal, and in birds and fishes they are nucleated; in us they are only nucleated in fœtal life and in disease. The mononuclear and polynuclear leucocytes are really separate organisms living in us, and they have qualities which it is very difficult to call anything else but consciousness; so that it is a subtle distinction to draw the line between the parasites—which these leucocytes are, in a way—which are part of us, and those that are not. When the balance of power is well preserved amongst our leucocytes, when they are working well together, then all is well with us; if we are ill, it is because they are quarreling with themselves or with an invader, and

we send for Sir Almroth Wright to pacify or chastize them with his vaccines.

So that, as Darwin said, "An organic being is a microcosm, a little universe, formed of a host of self-propagating organisms, inconceivably minute and numerous as the stars in heaven"—as we ourselves are but parts of life at large.

The three main functions of blood are: that it is a means of respiration, a means of nutrition and a defense against invading organisms.

And now to these latter. A blood parasite proper is a living being, vegetable or animal, passing part or the whole of its existence in the blood of another living being, upon which it lives, this being obligatory and necessary to its life-cycle.

It was in 1841 that the first blood parasite was seen by Valentin in the blood of a fish, and two years later Gruby gave the name *Trypanosoma* to an organism he found in the blood of a frog. But since Laveran's discovery of the malarial parasite in 1880, we have learned to differentiate many other parasites as causal agents of such diseases as I shall mention later in connection with the various parasites. But we know as yet dangerously little about most of them, so that we have strenuously to resist the temptation to make our account of them sound too harmonious, before we have found half the notes of the chord we are trying to play. We speak, as it were, with authorized uncertainty, and there are parts of our science which, after all, are only expressions for our ignorance of our own ignorance. These parasites have a very complicated life-history; part of their life-cycle is passed in the blood of man or beast, and part in various parts of the body of some blood-sucking invertebrate, such as a fly, mosquito or tick, which transfers the parasite to another animal whilst feeding from him. It was thought formerly that blood parasites would be a restricted order, but the work of recent years has shown that they have an enormous distribution both geographically and as regards their hosts. For instance, during the last five years I have had the opportunity of examining all the animals (in the large sense of the word) which have died in the Zoological Gardens. I have examined the blood of over 8,000 animals, coming from all parts of the world, and I have found parasites in the blood of 587 of them, that is, in about 7 per cent., and in 295 species of animals I have found them for the first time. I mention this just to give you some numerical idea of their occurrence and distribution.

It will be better to take first those parasites which live in the plasma, and then those that live in the corpuscles, rather than to attempt to take them in their, at present rather uncertain, biological order; and I will begin at the bottom, biologically speaking, that is, with the bacteria which are plants. These only require mention, since they do not live in the blood as parasites proper, but only as accidental parasites—that is, parasitism is not necessary to their life-cycle; they get into the blood in the later, or in certain, stages of certain diseases.

An example is the blood of a Senegal turtle-dove which died in twenty-six hours from fowl cholera. This bacillus was discovered by Pasteur, and is interesting, as it was his work upon it which led to his discovery of the attenuation of a virus, and of its transformation thereby into a protective vaccine.

The first parasites proper I shall mention are the spirochetes. These have at present rather an insecure position in our idea of nature; they were formerly classed close to the bacteria, but now they are placed tentatively among animals, and

they are not yet quite sure of their place. But they, nevertheless, although insecure of their place in the books, produce grave diseases, such as relapsing fever, tick fever of man, the spirochetoses of horses, oxen and birds, syphilis and yaws. They, with the exception of the last two, are carried by, and developed in, ticks and bugs; and in tick fever the parasite is also found in the nymph form of the tick, and this is one of the rare instances of heredity of a parasite.

The spirochete of relapsing fever in man was discovered by Obermeier in 1868, and he died from inoculating himself with the blood of a patient with the disease. He was one of the first scientific martyrs; he established our knowledge of the cause of this disease at the expense of his own life.

We will now take a long jump to the filariæ. These are nematode worms, the embryo forms of which live in the blood; the parent forms, being too large to get through the capillaries, live in many other parts of the body. The larval form lives in the body of some invertebrate—in a few known cases in a mosquito, or in a crustacean. The microfilariæ were discovered by Demarquay in 1863. Many of them show a remarkable periodicity, some appearing in the blood at an exact hour at night, and some in the day, for which phenomenon there is at present no satisfactory explanation.

Some are short, and some long, and some are encapsuled, others not. Filariæ cause various diseases, probably elephantiasis, and certainly enormous varicosities of the lymphatics, chyluria, chylous dropsy, Calabar swelling and certain tumors.

We now come to the trypanosomes. They are flagellated organisms, which are the cause of many deadly diseases in men and animals; such as sleeping sickness, nagana (or tsetse-fly disease), surra, mal-de-caderas, dourine and others. They are transferred from animal to animal by biting flies, fleas, lice and leeches, in which the sexual part of their life-cycle takes place. The first one was seen in the blood of a frog by Gluge in 1842.

A type example is *T. Lewisi* in the blood of a rat. This was discovered by Lewis in 1878, and is found in about 25 to 29 per cent. of wild rats. Some die, but most recover and become immune; it is a very specific parasite, and can not be transferred to any other kind of animal.

The *T. Brucei,* causing nagana or tsetse-fly disease, probably exists in the wild game of South Africa, much as the *T. Lewisi* does in the wild rats, but when it is carried by the tsetse-fly to domesticated animals it kills them one and all in enormous numbers.

The *T. Gambiense,* which causes sleeping sickness, was first seen by Dutton in 1902, and is carried by another species of tsetse-fly.

Nature attempts to fight against these invaders by phagocytosis. The parasites, however, multiply so rapidly that this method of attack is not very effectual; it can only be so in very early infections, and probably it then often is, that is, before the parasite has had time to start dividing. At the present time the question of trypanosomosis amongst man and animals is, for many countries which have colonies, of the greatest economic importance, so that a great deal of work has been done in the attempt to find a cure. A great many drugs, new and old, have been tried, and some good has been done. The first drug which was found to be of service was arsenic, first in simple and then in complex combination, and the sub-committee of the Royal Society, formed for the purpose of supervising experiments in this direction, suggested the trial of antimony in these

diseases, on account of its near chemical relationship to arsenic.

This has given better results than arsenic, and a commission is at present at work in Africa, in the Lado district, trying its effects on a large scale. We found that the salts of antimony were too rapidly eliminated from the body to be successful in the larger animals and man, and so we devised a very finely divided form of the metal itself which we put directly into the circulation, and this has given, so far, the best results. The leucocytes eat it up and transform it slowly into some soluble form, taking, in a horse, for instance, four days to dispose of one dose, and the effect of this is much more profound and lasting than that of the salts. But some trypanosomes always escape, since one dose is never sufficient for cure. In rats with nagana, in which the trypanosomes by the fifth or sixth day may number 3,000,000 per cubic millimeter of blood, the minimum number of doses for cure has been found to be four, and with this dosage it is possible to cure 100 per cent. of rats. So there is still some hope.

It is interesting in this connection to remember what Bacon, whose death, you know, was due to an experiment he undertook to prove the preservative action of intense cold upon animal bodies, says, "Laying aside, therefore, all fantastic notions concerning them, I fully believe, that if something could be infused in very small portions into the whole substance of blood . . . it would stop not only all putrefaction, but arefaction likewise, and be very effectual in prolonging life." His vision was prophetic!

The bird trypanosomes are very much larger than the mammalian variety, are very dense and move much more slowly.

An example of an organism very closely allied to the trypanosomes which is only found in fishes' blood, and is called a *Trypanoplasma,* has two flagella, and the micro-nucleus is very large. They are probably transferred by leeches, but very little is yet known of them.

There are other flagellated organisms which may appear in the blood and live there as accidental parasites. There is a kind of inflammation of the intestines in reptiles (in the large sense) which causes the mucosa of the intestine to become permeable, so that some of the organisms which live in the intestine are able to get into the blood and live there. The only mention of these organisms in the blood is by Danilewsky, who in 1889 found hexamitus in the blood of a frog and tortoise. When in the blood they appear to excite a general œdema and ascites. I have found them now in nine cases. These are interesting as showing the power of adaptation to new surroundings possessed by these parasites.

I now come to the intracellular parasites.

Schaudinn thought that the bird trypanosomes had an intracellular stage, and if this were so they would form a bridge between the extracellular parasites, of which I have shown you types, and the intracellular parasites we are about to consider. But Schaudinn seemed, with his very brilliant attainments, to want a little more ballast of medical earth-knowledge. His work on this point has not been confirmed, and he was probably misled by a double, or even treble infection, so that we must think of these intracellular parasites as quite distinct from the others.

I will take first the *Plasmodium præcox,* the cause of the malaria in birds, as this parasite is of great historical interest; for it was Ross's work on this organism and his discovery of the rest of its life-cycle in the mosquito, which enabled him—on account of the great likeness between this and the parasite causing human malaria—to

deduce from the one the etiology of the other, which was confirmed by Grassi and others. The *Plasmodium præcox* is, in many stages, so like human malaria that it can only be differentiated by the presence of the oval nucleus of the bird's red corpuscles. The life-cycle is very complex, part taking place in the blood of the bird, and another part (sexual reproduction) in the body of a mosquito. This parasite was first seen by Grassi in 1890; it is very widely distributed, and is very deadly to birds.

Human malaria has been known for centuries. Varro, who knew a good deal about what we should now call hygiene, more than a century B.C., thought that malarial fevers were due to invisible animals, which entered the body with the air in breathing, and Vitruvius, Columellus and Paladius were of the same opinion. Now we know that the mosquito is again the carrier, and that the sexual part of the parasite's cycle takes place in it, but whether the mosquito alone can account for all the phenomena of malaria is not yet quite certain.

There are three varieties of malaria in man—the tertian, quartan, and quotidian; in the tertian the cycle of the parasite in the body takes forty-eight hours, and in quartan seventy-two hours, and in pernicious malaria the fever is very irregular, but continuous. Whether there are three different parasites, or only one, which is altered according to its environment of host, climate, etc., is still apparently uncertain. Laveran and Metchnikoff believe in the specific unity of the parasite, whereas some observers want as many as five different species.

Just as in human malaria the pernicious form is distinguished by the elongated form of its gametes, so in birds there is a parasite which is distinguished, in the same way, from *Plasmodium præcox* by its very elongated gametes. This parasite is called *Hæmoproteus Danilewski*. Its development is unknown; it begins as a tiny irregular body in the red corpuscles of the bird, then it grows in the long axis of the cell and turns round the end of the nucleus. It is possible in these parasites to follow the process of impregnation, which normally takes place in some insect. By taking the blood when full of the long, fully-grown gametocytes, and keeping it for a time outside the body, this process can be followed.

First of all, the gametocytes escape from the blood-corpuscles and roll themselves up into a ball. Some of these remain quiet—the females, curiously, the macrogametocytes—whilst in the microgametocytes active movements are seen; then tailed processes are seen projecting from its surface, which at last get free and wander about in the blood, this constituting the origin of the microgametes from the microgametocyte. They then find a macrogamete, and penetrate into it and fertilize it. This fertilized macrogamete then alters its shape and becomes an ookinete, with the remains attached containing the pigment. It may enter a red corpuscle, but it usually breaks up, because it finds it is not in the stomach of the insect it intended to be in, but between two pieces of glass.

From *Hæmoproteus* it is easy to pass to a rare and undetermined parasite of the blood of birds called a *Leucocytozoon*. It occurs in the blood in the form of a long, spindle-shaped, unpigmented body. Very little is known of it except that it is found in its sexual forms. The earliest observers of this parasite—Danilewsky and Ziemann—believed the host-cell to be a leucocyte (hence the name), but Laveran has shown that it is a red corpuscle.

We now come to a group of parasites of great practical importance, the *Babesias*,

formerly called *Piroplasma,* which are the cause of Texas fever or red-water fever, malignant jaundice, East Coast fever, and biliary fever amongst domestic animals. We know, again, little that is certain concerning this group, except that they are unpigmented parasites of the red corpuscles, and are carried by ticks. They are the most destructive to the blood of any we know. In an ox, I have seen the red corpuscles decrease from 8,000,000—the normal—to 56,000 per cubic millimeter in two days.

Another important group, the *Leishmania,* is still uncertain of its exact position. In the body they occur as small bodies with a nucleus and micro-nucleus, but when cultivated on artificial media they become flagellated organisms of a herpetotomas type. It is not quite certain what insect plays the part of carrier, but the different varieties of this group cause the diseases known as Kala Azar or tropical splenomegaly, Oriental sore, Delhi boil, Biskra boil, etc., and also infantile splenic anemia.

The last class are the Hæmogregarines. These are parasites of the red corpuscles of reptiles principally, but they have been described in mammals and birds. We only know certain stages of the greater part of them; they are large, sausage-shaped bodies, not pigmented, and they are supposed to be carried by leeches, ticks, lice and fleas. They generally have a capsule. In some instances the host-cell is enormously enlarged and entirely dehemoglobinized, but in most cases the host-cell is not enlarged.

I have now taken you over some examples of all the known types of blood-parasites, but, at best, the picture in your minds must be like that of a landscape taken from a railway carriage at full speed; and the result, I fear, only a kind of clarified confusion, but it will be something if I have succeeded in making it transparent at the edges. What must have struck you most is the smallness of our exact knowledge of many of these extraordinary organisms and the gaps that there are even in this. But the incitement to future work lies in this fact, for

Things won are done, joy's soul lies in the doing.

Henry George Plummer

SOME EDUCATIONAL PROBLEMS IN KANSAS[1]

Kansas partakes of the general educational life of our country and confronts in a large measure the problems presented in all other parts of the United States. Much criticism has been directed against public schools, whether common schools, high schools or colleges and universities. Part of this criticism has been constructive in its aim and founded upon a conscientious loyal purpose. Some of its has been destructive, without adequate basis, and founded upon ignorance or unworthy motives. The conditions that subject the schools to reasonable criticism have been found after investigation to be due not so much to the schools or institutions themselves as to the character of our community life quite beyond the sole control of schools and colleges. This has been true of Kansas and of its institutions of higher education; and the most searching criticism has shown them to be on the whole sound, economical in their management, praiseworthy in their motives and purposes. That there has been waste in education of all degrees there is no doubt, but if we set up the rule that those agencies of life that present waste must be abolished or their fundamental organization and purpose changed, then all the agencies of life must be abolished or their fundamental purpose and organization

[1] Semi-centennial of Kansas State Agricultural College, October 29, 1913.

changed for there is no perfection in any human agency and all are subject to the charge of waste. I believe that the charge of waste, so far as money waste is concerned, has less foundation in connection with education than in connection with most other agencies of our American life. This I believe to be true of Kansas also. Waste in education does not necessarily arise through a large expenditure of money. It arises much more from the lack of large expenditures of money, for all those who are acquainted with the great problems of education will probably agree that there is no waste so great, no extravagance so unjustifiable as a false economy in education and there is no use of funds so truly economical, so immensely efficient as an expenditure of public funds upon education as large as the demands of our time and the outlook for the future makes necessary. Therefore, as I view it, the problem with us is not the reduction in the expenditures by the state for education but a large increase in the expenditures of the state, and a most careful and efficient administration of those expenditures on the basis of the most expert and experienced advice that our most expert and experienced administrators can give.

2. That there has been a change in the general purpose of education there can be little doubt. This was inevitable in connection with the movement toward the democratization of American life. It is another aspect of the movement, whether we like it or not, to achieve a real democracy in the United States. To accomplish this without the aid of the schools would be most difficult for the schools are the main agency by which the achievements of the past are handed down to succeeding generations and by which fundamental changes in the general operations of our life must be maintained. If the purpose of education remained the same, if the intellectual discipline of our schools remained absolutely rigid, progress would be almost if not quite impossible. Every decade brings its new discoveries. All of these accretions must be added to what we are to hand down to the rising generation. The modern public high school, the modern public university, bringing as they do within their sphere of influence a vast throng of boys and girls from every walk of life had to be adjusted to the needs of this heterogeneous mass and the institutions that were originally planned for the development of a profession or for a few callings in life or for the more fortunate classes in our country have been obliged to adapt themselves to the new aspect of our national life. No change so great as this may ever go on without its accompanying dangers. This change has been so rapid and so revolutionary as to make permanent adjustment difficult. The danger here lies in the possibility that the basis of education may become the purpose solely or largely to train for the ability to accumulate wealth. In other words it may become materialistic. Whatever defects the old training had it was free from materialism. Therefore, as I view it, the problem in Kansas is by far-sighted wisdom to secure such permanent adjustment as shall make our institutions of learning hospitable to all the permanent shiftings of our community life and at the same time to avoid a materialistic purpose and basis of education.

3. Vocational education has been a necessary outcome of the general industrial development in our American life, and of the change in the purpose of our education. In 1889–90 there were only 203,000 pupils in the public high schools in America. There were in 1911–12, 1,105,000. In 1889–1890 there were in colleges, universities

and schools of technology, 66,000. In 1912 there were 198,000. That this great multitude of boys and girls crowding into our colleges and universities should not be shunted off from the trades and industries, from a contact with and a knowledge of hand labor, that they should be able to earn a competent living, vocational training was inevitable. In this connection there are at least two things that ought by all means to be considered. In the first place any arrangement of American education that shall lead to stratification of our population by which one class is turned perforce in one direction and another in another would be a national calamity. No such stratification as has occurred in Germany could be tolerated in America. No teacher or administrator must ever have the authority to say to one boy that he may go on into the high school and prepare for college and issue with all that the college or university can give him, and to another boy that he must go into a trade school and issue as a hand laborer. There must be absolute freedom for the choice of the individual and the road must be open from the kindergarten to the university for every boy or girl that has any aspirations for the highest training. Then again, if we are to have vocational training and if we are to deal with this great multitude in an adequate fashion, vocational guidance must go with vocational training. There must be adequate supervision, adequate suggestion and guidance by which boys and girls may be made acquainted with the different trades, industries and professions; given some adequate insight into the purposes and requirements of each so that they may have not coercion but assistance in arriving at the task in life that each desires to perform. I hope to see in the university over which I preside the development of competent agencies for investigation into the individual aptitude of students and the introduction of courses and other means for vocational guidance and information concerning trades, industries, professions and business callings.

4. There is no aspect of our education whether in the United States or in our own state that is more disheartening or that raises more questions of doubt than the adequate supply and the adequate quality of teachers for our schools of every grade. To overcome this, undoubtedly two things are absolutely necessary. First, the independence of the teacher, permanency of tenure, the respect that is due to a great and dignified calling. No class of men or women of any spirit or ability will enter a profession, or having entered long remain in it, if their independence, their right of initiative and free speech as American citizens is in any way in question. Nor will they enter a profession or long remain in it if their tenure of office is lacking in permanency or subject to any uncertainty arising from the exigencies of politics or too frequent changes in administrative policy. Unless these evils are remedied I fear, from many evidences during the last few years, that we must look for a decrease rather than an increase in the number and quality of our teachers.

But perhaps the most vital consideration in this respect is the condition of teachers' salaries. I refer here to the salaries in all grades of schools, including colleges and universities. The salaries in our colleges and universities are, so far as relation to purchasing power and living conditions is concerned, lower I believe than they have ever been in the history of the institutions. The report of the commissioner of education for 1912, page 29, has a section dealing with this point. It gives a summary of the report of a committee of the National Education Association on

teachers' salaries and the high cost of living. Taking it as the basis of authority we may note that

> The United States Bureau of Labor found that in 1911 wholesale prices were 44.1 per cent. higher than in 1897. Measured by wholesale prices a teacher whose salary had remained fixed at $1,000 since 1897 would have no greater purchasing power in 1911 than $693 possessed in the earlier year.
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> The increase of wholesale prices has, of course, been reflected to a greater or less degree in retail prices generally. . . . In June, 1912, retail food prices were 61.7 per cent. higher than the average for 1896.

In any college or university, therefore, where the salaries of professors have remained at from $2,000 to $2,500 the teacher has found a tremendous decrease in the actual value of what he received. The result has been, as the Carnegie Foundation reports so ably show, a drawing off from the teaching profession on the part of many able men and women who for the good of our education ought to have remained. A further continuance of this condition will draw off a still greater number and make it more and more difficult to persuade men especially to enter the teaching profession.

5. One of the great problems confronting education in Kansas as elsewhere is still the moral and religious problem. If any were misled years ago into the belief that intellectual training provided sufficient safeguards and moral standards, certainly our experience in the last decade must have disillusioned him. There is nothing so futile as the attempt to make intellectual training take the place of moral and religious training and no man is so dangerous as the educated man gone wrong. In my judgment the grave point of danger in our schools is not the college or university. Long experience leads to this conclusion and statistics and general observation point inevitably to the same conclusion. The grave point of danger is the home and high school and here must the great work be done, for after all ours with all its defects is a Christian civilization. Historical Christianity is the basis of our whole life and we, as a nation, shall stand or fall with it.

6. One of the problems confronting all states having several institutions of higher education is their proper correlation. The demand for such correlation in Kansas has come about to some extent from the belief that large duplication exists which might easily be eliminated by an arbitrary decree fixing the field of each institution. It has been thought by some that it would be feasible to define precise and narrow limits for the institutions and to confine them strictly within such limits. As soon as one considers this problem carefully with a full understanding of practical conditions it becomes evident that such a narrow delimitation is impossible and if it should be undertaken upon any precise theory it might result in disastrous dismemberment of our institutions and great harm to our education. No one, so far as I know, would undertake to defend duplication which is artificial and gratuitous, which has no substantial basis and is not a necessary concomitant of the genius of the institution itself. But every institution must round out its life and do what necessarily arises in its field of operation.

The demand for correlation has arisen in the second place from a belief that large duplication exists, necessarily giving rise to an unusual and useless cost of education. The total cost of higher education in Kansas is large and at this point it is commonly assumed that the cost per institution and per student must be excessive and that duplication must be the cause of it. This belief is unwarranted. Now, there

is one infallible test of whether or not education in our Agricultural College or University is costing too much and that is a comparison of our per capita cost with that of other like institutions in other states, for taking a long series of years together there is no standard of the necessary cost of education so accurate as the average cost in institutions of practically the same grade. Indeed it would be impossible for any considerable duplication of effort to exist in Kansas without largely increasing the cost per student. To show that the cost per institution and per student in Kansas is not large one has only to compare the average cost of other institutions and their cost per student with our own. Such a comparison will show in practically every case that without question the cost of education in the Kansas Agricultural College and the University of Kansas, both as to the institutions themselves and as to their cost per capita, is below the average of other institutions of like rank. The large cost of education in Kansas arises rather from the unprecedented number of young people that Kansas undertakes to educate. There were students, residents of Kansas, in the University and Agricultural College in 1911–12, to the number of 4,594. If Iowa had educated as many according to population as Kansas, instead of 4,163 resident students in its University and Agricultural College it would have had 6,317; Wisconsin, instead of having 3,945 would have had 6,341; Indiana, instead of 3,889 would have had 7,339; Michigan instead of 4,509 would have had 7,636; Missouri instead of 2,740 would have had 8,949, and Illinois instead of 3,504 would have had 15,322. The question that arises, therefore, is not excessive cost per student but shall Kansas continue to educate its young people in unusual and ever increasing numbers and pay the necessary cost? I believe that most of us would answer most emphatically in the affirmative.

The question of coordination of institutions suggests another danger that might arise through an attempt to standardize institutions within a given state and make them uniform in their purpose, their spirit and their outlook. I believe that nothing worse could happen in Kansas education. The value of our institutions lies largely in their being different, in having different problems to solve, in having a different life, a different point of view. A college or a university has a soul as has a man and the personality of an institution and the integrity of its life at all hazards must be maintained. It must be held to its primary purpose and acquit itself valiantly in its own domain. It seems to me, therefore, that the watchword in Kansas must be cooperation; that the teaching bodies of each institution must have and exercise powers of initiative and internal control in order to visualize and develop their own problems and maintain their own integrity and independence; that at the same time they must cooperate most fully with the board of administration and every other proper agency of education in their every endeavor to secure a true and fundamental cooperation to the end that our education, while as diverse as the different agencies connected with it, shall after all have a true and noble unity.

Frank Strong,
Chancellor

University of Kansas

THE AMERICAN SOCIETY OF NATURALISTS

The American Society of Naturalists in affiliation with the American Society of Zoologists, the American Association of Anatomists, and the Federation of American Societies for Experimental Biology, will hold its thirty-first

meeting at Philadelphia, under the auspices of the University of Pennsylvania, on Wednesday, December 31, 1913.

The morning session will be open for papers on evolution, genetics and related subjects from members or invited guests, titles of which with estimated length of delivery must be in the hands of the secretary by December 1. Requests for microscopes or for space for demonstrations should also be sent to the secretary.

The program of the afternoon will be a symposium on "The Scope of Biological Teaching in relation to New Fields of Discovery." The annual dinner will be held in the evening of the same day.

Headquarters of the affiliated societies will be at the Hotel Walton, Broad and Locust Streets.

BRADLEY M. DAVIS,
Secretary
UNIVERSITY OF PENNSYLVANIA

THE AMERICAN PSYCHOLOGICAL ASSOCIATION

MONDAY, Tuesday and Wednesday, December 29, 30 and 31, have been selected as the dates for the twenty-second annual meeting of the American Psychological Association. At the invitation of the psychologists at Yale University, the sessions will be held in New Haven, in affiliation with the American Philosophical Association.

One joint session of the two societies will be arranged. At the present time it is still uncertain whether this session will be devoted wholly to discussion of the theme, "The Standpoint of Psychology," or whether a varied program will be made by selecting from among the papers offered, a few of those that promise to be of greatest interest to the membership of both associations.

Round Tables.—It has been proposed to provide time on the program for informal round-table conferences of small groups of psychologists who are particularly interested in some more or less specialized subject. "Psychological Tests of College Freshmen," for example, is one of the topics in which several laboratories seem to have a waxing interest just now, and doubtless an informal interchange of ideas and experience would have some value. More or less related themes are "Psychological Tests and Vocational Guidance"; "Graded Measurements of Adult Intelligence"; "Problems of Psychological Research among Defectives and Delinquents." A timely topic, sure to call out a clash of ideas, has been suggested to the secretary from different quarters, "The Movement toward Divorce of Philosophy and Psychology." Is psychology, more than any of the other natural sciences, dependent on philosophy? In how far are the two disciplines being benefited by the rapidly spreading tendency toward separation of the two departments in university organization?

This year, as usual, the main portion of the program will be reserved for reports of experimental research. The experience of recent meetings has convinced the committee that these reports are of the greatest value when they do not undertake to go into detail, but aim instead to state clearly, but briefly, the nature of the problem and the method of attack, and then pass at once to the general summary of the results and a discussion of the conclusions reached, leaving the mass of detailed results to be presented when the research is published in full. It is impossible to compact an effective report of research into the ten or fifteen minutes allowed, when an effort is made to include in it a bulk of detailed information which is beyond the maximal span of the attention of an average psychologist.

Cards for use in sending in the titles of reports will be mailed to all members shortly.

The Yale laboratory affords excellent quarters for the display of apparatus. Members are asked to inform the secretary of any new form of apparatus or any useful demonstration device which has not already been brought to the notice of this society. Improvements on standard appliances are often quite as worthy of attention as entirely new forms. The expense of transportation will, up to a certain limit, be assumed by the Association.

The secretary wishes this year to gather together a varied assortment of printed and mimeographed syllabi, outlines, laboratory directions, charts, blanks, bibliographies of supplementary and suggested readings, review questions, examination questions and the like, so that we may all see something of the minor aids to instruction which our colleagues are employing. He begs that each one who reads this announcement will take the few moments of time necessary to mail to him at once a packet containing samples of all material of this sort which happens to be accessible.

W. V. Bingham,
Secretary

Dartmouth College

THE DANA CENTENARY

In commemoration of the great geologic work of James Dwight Dana, Yale University will hold a centenary celebration next December, to consist of a series of lectures, culminating in a Dana Memorial volume on "Problems of American Geology." The lectures will be given on the Silliman Foundation, and are open to all interested persons. The speakers and their respective subjects are as follows:

PROBLEMS OF AMERICAN GEOLOGY

Introduction

"The Geology of James Dwight Dana," Professor William North Rice, of Wesleyan University, Tuesday, December 2, 8 P.M.

I. *Problems of the Canadian Shield*

"The Archeozoic and its Problems," Professor Frank Dawson Adams, of McGill University, Thursday and Friday, December 4 and 5, 5 P.M.

"The Proterozoic and its Problems," Professor Arthur Philemon Coleman, of the University of Toronto, Wednesday and Thursday, December 10 and 11, 5 P.M.

II. *Problems of the Cordilleras*

"The Cambrian and its Problems," Dr. Charles Doolittle Walcott, of the Smithsonian Institution, Monday, December 15, 5 P.M.

"The Igneous Geology and its Problems," Professor Waldemar Lindgren, of the Massachusetts Institute of Technology, Tuesday, December 16, 5 P.M.

"The Tertiary Structural Evolution and its Problems," Dr. Frederick Leslie Ransome, of the United States Geological Survey, Wednesday, December 17, 5 P.M.

"The Tertiary Sedimentary Record and its Problems," Dr. William Diller Matthew, of the American Museum of Natural History, Thursday and Friday, December 18 and 19, 5 P.M.

SCIENTIFIC NOTES AND NEWS

It is announced that M. Charles Richet, professor of physiology in the University of Paris, has been awarded the Nobel prize for medicine.

The Royal Society of Edinburgh has elected honorary fellows as follows: Professor Horace Lamb, F.R.S., professor of mathematics in the University of Manchester; Sir W. T. Thiselton-Dyer, K.C.M.G., F.R.S., formerly director of the Royal Botanic Gardens, Kew; Dr. G. E. Hale, director of the Mount Wilson Solar Observatory (Carnegie Institution of Washington); Professor Emil C. Jungfleisch, professor of organic chemistry in the College of France, Paris; Professor S. Raymón y Cajal, professor of histology and pathological anatomy in the University of Madrid; Professor V. Volterra, professor of mathematics and physics in the University of Rome; Professor C. R. Zeiller, professor of plant paleontology in the National Superior School of Mines, Paris.

Professor W. M. Davis, of Harvard University, has been granted an appropriation from the Shaler Memorial Fund to defray in part the expense of his trip to the South Pacific to study the physiographic evidence relating to the problem of coral reefs.

At its last meeting held on November 12, 1913, the Rumford committee of the American Academy appropriated the sum of $250 to Professor Louis V. King, of McGill University, to defray the expenses of computation for his research on "The Scattering and Absorption of Solar Radiation in the Earth's Atmosphere."

The council of the Royal Meteorological Society has awarded the Symons Gold Medal to Mr. W. H. Dines, F.R.S., in recognition of

the valuable work which he has done in connection with meteorological science. The medal will be presented at the annual meeting of the society on January 21, 1914.

PROFESSOR JULIUS STIEGLITZ, of the department of chemistry in the University of Chicago, is a member of the committee appointed by the Chicago section of the American Chemical Society to cooperate, if desired, with the mayor of Chicago in the solution of the city's waste problem. Other members of the committee are Professor John H. Long, of Northwestern University, and Professor Harry McCormack, of the department of chemical engineering in the Armour Institute of Technology.

PROFESSOR E. E. SOUTHARD, of Harvard University, has been made a member of the board of scientific directors of the Eugenics Record Office, Cold Spring Harbor, N. Y. Professor Southard has also been made a member of the consulting board for the laboratory erected by the Bureau of Social Hygiene in connection with the State Reformatory for Women at Bedford Hills, N. Y.

WE learn from *The Observatory* that owing to the continued illness of Professor Sir Robert Ball, Professor Newall has been made deputy director of the Cambridge Observatory.

MR. H. KNOX SHAW has been appointed superintendent of the Helwân Observatory, Egypt.

EDGAR T. WHERRY, Ph.D. (Pennsylvania, '09), lately assistant professor of mineralogy at Lehigh University, has been appointed assistant curator of mineralogy and petrology in the department of geology, United States National Museum, succeeding Mr. Joseph E. Pogue, transferred to the United States Geological Survey, and James C. Martin, Ph.D. (Princeton, '13), has been appointed assistant curator of physical and chemical geology, succeeding Mr. Chester G. Gilbert, now curator of mineral technology.

MR. THOMAS LANCASTER WREN, who took a first class in the mathematical tripos in 1909 and 1911, and Mr. Franklin Kidd, son of Benjamin Kidd, the author of "Social Evolution," who took a first class in the natural science tripos in 1912, have been elected to fellowships in St. John's College, Cambridge.

DR. S. CHAPMAN, chief assistant at the Royal Observatory, Greenwich, has been elected a fellow of Trinity College, Cambridge.

THE clinical congress of surgeons of North America was held in Chicago last week. In addition to the clinical demonstrations held in the various hospitals of the city, eight evening sessions were devoted to the reading and discussion of papers. Among those who made addresses before the congress were Dr. Edward Martin, Philadelphia; the retiring president, Dr. George E. Brewer, of New York; the incoming president, Sir W. Arbuthnot Lane, London; Dr. Carl Beck, Chicago; Dr. John B. Deaver, Philadelphia; Dr. Howard Kelly, Baltimore; Dr. C. J. Gauss, Freiburg; Dr. Roswell Park, Buffalo; Dr. James Ewing, New York, and Dr. Charles Mayo, Rochester.

PROFESSOR H. MONMOUTH SMITH, of Syracuse University, who has for several years been a volunteer investigator in the nutrition laboratory of the Carnegie Institution of Washington, Boston, has recently accepted a position on the laboratory staff in connection with the respiration calorimeters.

DR. ALOIS RIEHL, professor of philosophy at the University of Berlin, and formerly rector of the university, will give two lectures, in German, in Emerson Hall, Harvard University, on the afternoons of November 17 and 18. The topics are "Nietzsche" and "Nietzsche and Bergson."

AT the regular monthly meeting of the Cosmos Club on November 10, Dr. Bailey Willis gave an address on "Present Day Conditions in Argentina."

THE eighty-eighth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Professor H. H. Turner, F.R.S., Savilian professor of astronomy in the University of Oxford, his title being, "A Voyage in Space." The lectures will be experimentally illustrated, and the subjects are as follows: The Starting Point—Our Earth, The Start

through the Air, Journeying by Telescope, Visit to the Moon and Planets, Our Sun, The Stars.

Arthur J. Frith, professor of engineering in the Armour Institute, Chicago, died on November 10.

The death is announced of Dr. Arthur Edgar, instructor in chemistry at Columbia University.

Dr. Edwin Klebs, the well-known pathologist and bacteriologist, died at Dortmund, on October 21, aged seventy-nine years.

Sir John Batty Tuke, M.D., member of parliament for the universities of Edinburgh and St. Andrews, and Morison lecturer on insanity and mental diseases in the Royal College of Physicians of Edinburgh, died on October 31, aged seventy-eight years.

Dr. Adolf Hoffman, professor of geology in the mining school at Przibram, has died at the age of sixty years.

Dr. Simon von Nathusius, professor of agriculture at Halle, has died at the age of forty-eight years.

The death is also announced of Dr. Ferdinand Blumentritt, of Leitmeritz, in Bohemia, known for his scientific work in the Philippine Islands.

The U. S. Civil Service Commission announces an examination for assistant in agricultural technology, for men only, on December 3, 1913, to fill vacancies in this position in the Bureau of Plant Industry, Department of Agriculture, Washington, D. C. The eligibles obtained from this examination will be classified in two groups, with salaries ranging as follows: Group A, $1,600 to $2,250 per annum; group B, $1,200 to $1,440 per annum. The services of the eligibles to be selected from Group A are desired in the laboratory of agricultural technology in the preparation of the official cotton grades, their work requiring an intimate knowledge of cotton grading and the various processes of cotton manufacture.

M. Durandeau, of Angoulême, has bequeathed £2,000 to the Pasteur Institute, Paris, for the foundation of a prize for researches on the cure of meningitis.

The International Congress of Hydrology just held at Madrid decided that the next meeting should take place two years hence at Lyons.

At the twenty-third annual meeting of the Ohio Academy of Science, which will take place at Oberlin College on November 27, 28 and 29, in addition to the reading of papers, an address will be given by Professor L. B. Walton, the president of the academy, on "The Evolutionary Control of Organisms and Its Significance" and an illustrated lecture on "Sound," by Professor Dayton C. Miller, of the Case School of Applied Science.

A regular meeting of the American Physical Society will be held in Chicago on Friday and Saturday, November 28 and 29. On Friday afternoon there will be a special session to discuss "The Photoelectric Effect and Quantum Theory."

A memorial meeting to the late Reginald Heber Fitz, Hersey professor of the theory and practise of physic, emeritus, was held in the Harvard Medical School, November 17. Addresses were made by Dr. W. W. Keen, of the Jefferson Medical College; President Charles W. Eliot; Dr. Henry P. Walcott, chairman of the Board of Health of the State of Massachusetts; Dr. William Sydney Thayer, of Johns Hopkins University, and Dr. William T. Councilman, of the Medical School.

The faculty and the graduate students of the department of botany in the University of Illinois have recently organized a society known as "Silphium." The purpose of the organization is the presentation of original articles by the members, the review of recent literature, and also to obtain a better acquaintance with the flora of the immediate region. Dr. T. J. Burrill, professor emeritus of botany, has been chosen its honorary chairman.

The Physical Science Club of Oberlin College has organized for the year with Dr. Moore, associate professor of physics, as president, and Professor Hubbard, head of the department of geology, as secretary and treasurer. The opening meeting was addressed by Dr. Stetson, head of the department of psy-

chology, who spoke on "The Introduction to Science." The Physical Science Club is composed of members of the teaching staff, graduate students and qualified undergraduates in the physical sciences. The members meet each week for the presentation of research work, special papers and general discussion.

AT the completion of its fiftieth volume, *The American Chemical Journal*, founded and edited by Dr. Ira Remsen, will be discontinued as a separate publication and will be incorporated, from January, 1914, with the *Journal of the American Chemical Society*.

PURSUANT to arrangements made at the Eighteenth International Congress of Americanists, in London, 1912, the Nineteenth Congress will meet in America in 1914 in two sessions, the first at Washington, from October 5 to 10, and the second at La Paz, Bolivia. The session at Washington will be held under the auspices of the Smithsonian Institution, in cooperation with the George Washington University, Georgetown University, the Catholic University of America, the Anthropological Society of Washington, and the Washington Society of the Archeological Institute of America. During the session an excursion will be made to the highly interesting aboriginal quarry and workshop at Piney Branch, District of Columbia; and following the congress it is expected that two excursions will be arranged, one to Ohio for the examination of ancient mounds, the other to New Mexico for the study of ancient ruined pueblos and cliff-dwellings, as well as of the present Pueblo Indians in their native environment. The officers of the organizing committee are: *President*—William H. Holmes; *Secretary*—Ales Hrdlicka; *Treasurer*—Clarence F. Norment.

WORD has been received in Cambridge that the collection of Egyptian objects made by Professor Reisner for the Harvard University Museum has been partially destroyed on the way to America. The ship which was bringing it caught fire and was forced to return to a German port. The extent of the damage has not yet been determined. The collection consisted of prehistoric skeletons, pottery, flints and a series of Egyptian anatomical remains.

WE learn from the *Electrical World* that at a meeting in Brussels on October 13 a "Commission Internationale Scientifique de Télégraphie sans Fil" was established for the scientific study of radio-telegraphic waves and their phenomena. The president is Mr. W. Duddell, of London; the secretary, M. Robert Goldschmidt, of Brussels; the vice-president, Professor W. Wien, of Jena. On and after January 1, 1914, at least until March 1, 1914, certain test messages will be sent from a station in Brussels at hourly intervals, on a wavelength of 3,300 in. Check measurements of the wave frequency, group frequency, power and other details will be made and recorded at Brussels. Observers are invited to measure these signals, as often, and at as many different places, as possible. It is hoped that national committees may be regularly appointed to cooperate in the movement, the objects of which are to increase the knowledge of electric radiation and meteorology. The distance from Brussels to New York is in the neighborhood of 4,000 statute miles, and to Chicago about 5,000; so that the signals which one can hope to receive in this country from Brussels are likely to be very weak. However, if the limiting distance at which these signals can be detected is determined in America, that fact will have significance and utility.

THE *Journal* of the American Medical Association states that an attempt is being made to establish, at the Army Medical Museum, Washington, D. C., an extensive library and lantern and stereoscopic slides of radiographs, representing the work of radiographers who have done particularly notable work along certain lines. Enough slides have already been received to make the collection of value for reference and for teaching purposes at the Army Medical School. Those who have already contributed to the collections are Dr. Lewis Gregory Cole, New York City, slides of stomach, lung and kidneys; Dr. William H. Dieffenbach, New York City, slides of diseases of bones; Dr. Kennon Dunham, Cincinnati, Ohio, stereoscopic slides of the lungs; Dr. Walter C. Hill, Cleveland, Ohio, slides of dis-

eases of bone, and Dr. James T. Case, Battle Creek, Mich., slides of the alimentary tract. Others have promised to send slides, and it is the intention to add to the collection from time to time as important work is done. The collection is available for study by any civilian practitioner on application to the curator, Army Medical Museum, Washington, D. C.

We learn from the *Journal* of the American Medical Association that acting under auspices of the commission appointed by the Medical Society of the State of Pennsylvania for the Conservation of Vision that an active campaign is under way against ophthalmia neonatorum, needless eye injuries in the trades, trachoma, wood alcohol, wrong lighting of buildings and like causes of blindness. In addition to a large number of distinguished laymen, acting as advisory members, the Commission on Conservation of Vision includes Dr. Wm. Campbell Posey, Wills Eye Hospital, Philadelphia, chairman; Dr. Wm. W. Blair, University of Pittsburgh, Pittsburgh, Pa.; Dr. Clarence P. Franklin, Philadelphia; Dr. C. M. Harris, Johnstown, Pa.; Dr. Edw. B. Heckel, Pittsburgh, Pa.; Dr. T. B. Holloway, University Hospital, Philadelphia, secretary; Dr. Wendell Reber, Temple University, Philadelphia; Dr. Edward Stieren, Pittsburgh, Pa.; Dr. Lewis H. Taylor, president of State Society, Wilkes-Barre, Pa.; Dr. Wm. Zentmayer, Wills Eye Hospital, Philadelphia; Dr. Samuel G. Dixon, commissioner of health of the state of Pennsylvania, Harrisburg, Pa., honorary chairman.

Alaska coal fields continue to be undeveloped, according to the United States Geological Survey. The only coal being mined is some lignite coal taken out for local use at Cook Inlet, on Seward Peninsula, and at several other localities. The total production in 1912 did not exceed 100 or 200 tons. One oil company continued operations in the Katalla petroleum field in 1912, as in 1911. One of the two producing wells is said to have been sunk to a depth of about 800 feet. The oil is procured by pumping and is refined in a small plant located near Katalla, and the gasoline finds a ready sale in the coastal settlements of this part of Alaska. There are several other oil companies which control property in this field, but these seem to have done little in the way of development during 1912.

UNIVERSITY AND EDUCATIONAL NEWS

A gift of $4,350,000 to the Cornell Medical School is now officially announced. The name of the donor is withheld but he is believed to be Col. Oliver H. Payne, of New York City.

At the conference of the Association of American Universities, held November 6, at the University of Illinois, eighteen of the twenty-two institutions admitted to membership were represented as follows: University of California, Dean A. O. Leuschner; Catholic University of America, Professor D. W. Shea; University of Chicago, Dean Rollin D. Salisbury and Dean Albion W. Small; Clark University, Professor J. W. Baird; Cornell University, Dean E. Merritt; University of Illinois, Dean D. Kinley and Dean K. C. Babcock; State University of Iowa, Dean C. E. Seashore; Leland Stanford Junior University, Professor W. W. Willoughby; University of Kansas, Professor F. H. Hodder; University of Michigan, Dean K. Guthe; University of Minnesota, Dean G. S. Ford; University of Missouri, Dean I. Loeb; University of Nebraska, Dean L. A. Sherman; University of Pennsylvania, Dean H. V. Ames and Dean J. C. Rolfe; University of Wisconsin, Director G. C. Comstock.

The non-resident lectures in the graduate course in Highway Engineering at Columbia University appointed for the 1913–1914 session are as follows: John A. Bensel, New York State Engineer; William H. Connell, chief, Bureau of Highways and Street Cleaning, Philadelphia; C. A. Crane, secretary, the General Contractors Association; W. W. Crosby, chief engineer, Maryland Geological and Economic Survey, and consulting engineer; Charles Henry Davis, president, National

Highways Association; John H. Delaney, commissioner, New York State Department of Efficiency and Economy; A. W. Dow, chemical and consulting paving engineer; H. W. Durham, chief engineer of highways, Borough of Manhattan, New York City; C. N. Forrest, chief chemist, New York Testing Laboratory; Walter H. Fulweiler, chief chemist, United Gas Improvement Company; Frank B. Gilbreth, consulting engineer; George P. Hemstreet, superintendent, The Hastings Pavement Company; Samuel Hill, president, American Road Builders' Association; D. L. Hough, president, the United Engineering and Contracting Company; J. W. Howard, consulting engineer; Arthur N. Johnson, state highway engineer of Illinois; William H. Kershaw, manager, Paving and Roads Division, the Texas Company; Nelson P. Lewis, chief engineer, Board of Estimate and Apportionment, New York City; Harold Parker, first vice-president, Hassam Paving Company; Paul D. Sargent, chief engineer, Maine State Highway Commission; Philip P. Sharples, chief chemist, Barrett Manufacturing Company; Francis P. Smith, chemical and consulting paving engineer; Albert Sommer, consulting chemist; George W. Tillson, consulting engineer to the president of the Borough of Brooklyn.

DR. O. W. RICHARDSON, F.R.S., professor of physics in Princeton University, has been appointed to the Wheatstone chair of physics at King's College, London, in succession to Professor C. G. Barkla, F.R.S.

DR. KARL BOEHM, of Heidelberg, has been appointed professor of mathematics in the University of Königsberg as successor to Professor G. Faber.

DISCUSSION AND CORRESPONDENCE

ATOMIC IONIZATION AND ATOMIC CHARGES

IN a discussion of "The Rutherford Atom" in SCIENCE for August 22 Mr. Fulcher gives Kleeman's table of the relative ionization of different elements by the β and γ radiation and concludes that "atomic ionization seems to depend primarily upon the atomic weight, which is probably proportional to the number of electrons in the atom."

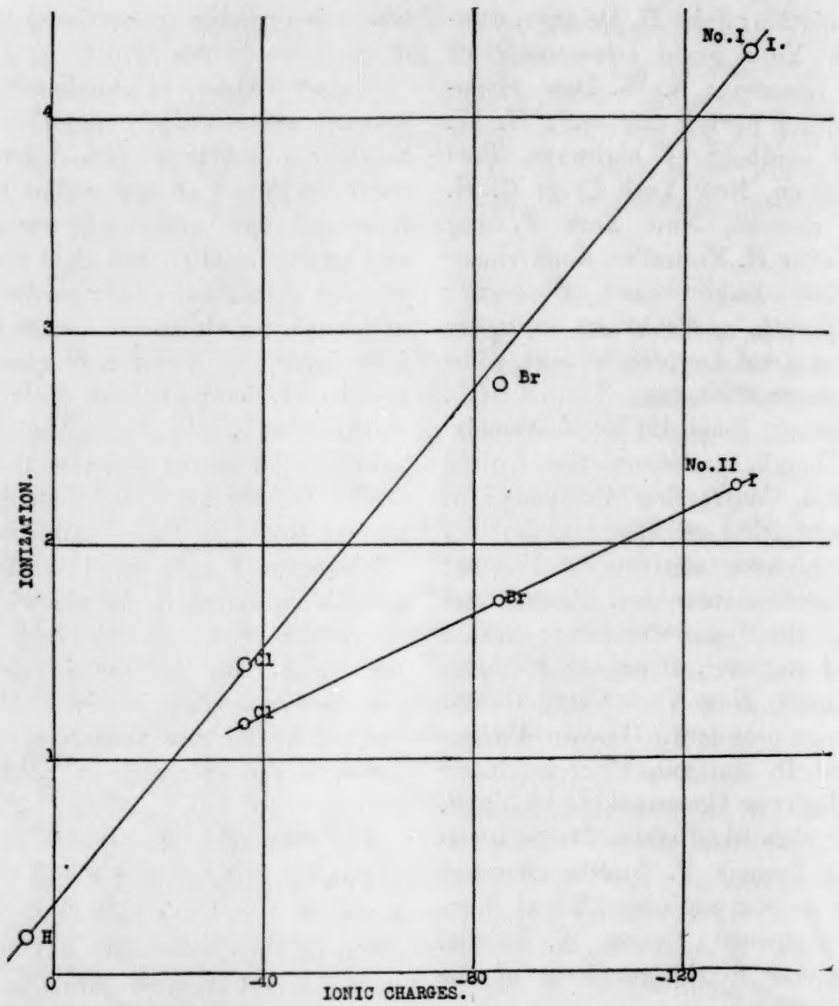
Whatever theory of atomic structure we may adopt, it seems certain that electrons are held to their atoms by electrical forces in which the mass of the atom can play no part. If a relation exists between the mass of an atom and its electrical charge, then a corresponding relation should exist between its mass and its attraction for electrons. Since the ionization investigated by Kleeman consisted in the separation of electrons from their atoms by the discharge of α, β and γ radiation through the substance, it seems probable that the weaker the hold of the atoms upon their electrons the greater would be their ionization.

Elsewhere I have tried to show that it is possible to calculate the electrical charges of a number of free atoms from their atomic mass and their velocity in electrolysis. If the above reasoning is correct, the charges calculated in this way should bear a definite relation to the ionization in Kleeman's investigation.

Unfortunately, the atomic charges can be calculated in this way for only four of the elements in Kleeman's table, but the indications given by these four seem so conclusive that I have thought it worth while to present them here. The four elements referred to are hydrogen, chlorine, bromine and iodine. Their relative ionization by the different rays and their charges as electrolytic ions are given in the table below.

Element	Ionization			Charge
	α Rays	β Rays	γ Rays	
H	.175	.18	.18	+ 5
Cl	1.16	1.44	1.44	— 36.5
Br	1.72	2.76	2.81	— 84.9
I	2.26	4.10	4.50	−132.5

It will be seen that while the ionization produced by the β and γ rays is practically the same, that produced by the α rays is much less. In either case, however, there is a constant relation between the ionic charges and the amount of ionization, showing that the greater the negative charge of the atom the



greater the ionization. This relation is shown graphically in the following curves, where No. I. shows the mean ionization produced by the β and γ rays as compared with the ionic charges and No. II. shows the same relation for the α radiation.

Fernando Sanford

Stanford University,
September 30, 1913

Scientific Books

The Maryland Devonian Books

The fine series of volumes issued by the Maryland Geological Survey (Professor Wm. Bullock Clark, state geologist) has recently been substantially supplemented in number and enhanced in worth by the publication of what may, for brevity, be styled the "Maryland Devonian Books."[1]

Following the tasteful pattern and admirable mechanical execution of the previous members of the series, the Devonian books constitute a graceful and enduring monument to the scientific vigor of the State of Maryland in which His Excellency, The Honorable Phillips Lee Goldsborough, and his distinguished colleagues of the Geological Survey Commission may take a just and satisfying pride. These books are three stout volumes and the golden device of the state which they carry on their covers declares that good men have done this work at the command of the presiding genius of Maryland. The accomplishment of this undertaking is the fulfilment

[1] Maryland Geological Survey: Lower Devonian. Text, 560 p.; Middle and Upper Devonian. Text, 719 p.; Plates (Lower Devonian, 1–98; Middle Devonian, 7–44; Upper Devonian, 45–73). Baltimore, The Johns Hopkins Press, 1913.

of a long promise and there need be no reserve in saying that the result is destined to be of great value and durable service to geological science.

Amid the diversified output of official reports on American geology there has been nothing like this before—a monograph of a single geological system and its component faunas, wherein is given in detail all that is known of the local development of the system within definite, if artificial, boundaries. The very expression of this fact, the realization that here is a work of ultimate reference in this field, brings with it the wish that other states might have done like this for their own domain and to the great advantage of those who seek to interpret the causes and sequences of geology along the broader lines. Many expert men have participated in the creation of this work; and here again, as so often, our venerable adages break down, for many cooks have neither spoiled the broth nor have many hands made light work; for first, the collaborators speak with reasonable finality, and again, the conception of the state geologist has labored long and hard, through many years, to this successful parturition.

The writer, having played a certain rôle in the rendering of this composition, must refrain from any exuberant notice of it. Nor would a critical review of the contents of the work be appropriate to these columns. All in due time the geological coroner with his hypotheses will be along to hold his inquest over the *corpus delicti*.

Volume 1 is devoted to the Lower Devonian, volume 2 to the Middle and Upper Devonian, and volume 3 consists of 165 plates, including 2,500–3,000 figures of fossils. The text volumes are embellished with many half-tones of geological scenery and accompanied by section sheets in cover pockets, and volume 1 carries a map of Maryland with the Appalachian distribution of the Devonian members accurately colored.

The introductory chapter on the general relations of the Devonian by Dr. Swartz points out succinctly the correlation of the formation in its various aspects, laying special emphasis on the discrimination of shore-line and subcontinental deposits at the east from contemporaneous marine deposits toward the west, in correspondence with later Devonian conditions northward in Appalachia. Professor Schuchert has presented the paleogeography of the Devonian with the aid of a series of paleogeographic maps of North America, which illuminate the procession of geographical changes and are serviceable for dogmatic purposes, even though recent blows of the hammer have torn some cavernous rents in them.

Dr. Prosser contributes the Historical Review and Bibliography.

The lengthy chapter on the Lower Devonian Deposits is the work of Messrs. Schuchert, Swartz, Maynard and the late R. B. Rowe, each responsible for a special section, Mr. Schuchert for the general introduction, Messrs. Swartz, Maynard and Rowe for the determinative stratigraphy, Dr. Swartz for the formational correlation. All four have shared in the "Local Sections," a chapter with which the geological portion of the volume closes.

In the descriptive paleontology which follows, the chapters and their authors are these: Cœlenterata, by Dr. Swartz; Cystidea, by Professor Schuchert; Crinoidea and Vermes, by D. W. Ohern; Bryozoa, by Drs. Ulrich and Bassler; Brachiopoda, by Professor Schuchert and Mr. Maynard; Mollusca and Trilobites, by Messrs. Ohern and Maynard; Ostracoda, by Drs. Ulrich and Bassler.

Thus briefly are the contents of this volume 1 indicated, but only the stratigrapher and paleontologist will appreciate the penetration of these analytical studies. Perhaps a leading feature of the stratigraphy is that expressed by the authors of their conception of the "Keyser member" of the series and the discussion of its correlation value with contemporaneous Appalachian deposits elsewhere. This is a succession of homogeneous limey sediments with a thickness of several hundred feet which are assigned a place at the base of the Devonian system. The deposits are continuous into Pennsylvania, but their equivalents northward in New Jersey

and New York are known by other names, and the discussion of their correlation raises delicate questions of fact and interpretation.

A very distinctive part of the paleontological chapters is Professor Schuchert's treatise on the cystids, a somewhat expanded account of his earlier descriptions and illustrations of these genera and species which attained a noteworthy development in the "Keyser member." There are attractive novelties among the crinoids, fine Bassler-photos appear among the Bryozoa, familiar drawings among the profusion of brachiopods and Mollusca, very interesting trilobites, regarding which the writer ventures to intimate (by way of neutralizing too much blandiloquence) that *Homalonotus swartzi* Ohern (Pl. 90) is *H. vanuxemi* Hall (*vanuxemi-major-perceensis* type), that *Dalmanites keyserensis* Swartz (Pl. 91, Figs. 5, 8, 9) is *D. micrurus* Green and that the object figured on Pl. 92 (Fig. 3) as the hypostoma of *D. multiannulatus* Ohern is not an hypostoma, but the very interesting bifurcate anterior limb of the cephalon.

Volume 2 opens with a discussion of the Middle Devonian, its subdivision and correlation, the major part of which is by Dr. Prosser, who has, with his usual perspicacity and justness, discussed the characters of these sediments and their correlation values. The Maryland geologists have felt impelled to follow the usage of the U. S. Geological Survey in adopting the term "Romney" (West Virginia place-name) to embrace the members which in New York are known as the Onondaga, Marcellus and Hamilton. Each of these is a recognizable factor in the composition of the Romney although the Onondaga has a distinctly peculiar development in lithology. And, says Dr. Prosser, "there are obstacles in the way of attempting to map these divisions separately due largely to the gradual change from the lithological characters of one member to another. . . . It was thought best to regard the stages as constituting one formation." The distinctive character of the Onondaga member is a matter of much interest because of its essential departure from its calcareous expression at the north. Limestone deposition is largely replaced by black shales of the type of the Marcellus, and would, in the opinion of Dr. Swartz, who has contributed the special section on this formation, indicate the increase southward of the replacement which is already evident in western New York.

Dr. Kindle contributes a concluding and philosophical chapter on the relations of the faunas to the sediments.

The systematic paleontology of the Middle Devonian has been prepared chiefly by Drs. Prosser and Kindle, the Bryozoa by Drs. Ulrich and Bassler.

Thereupon follows a treatise on the Upper Devonian deposits by Drs. Prosser and Swartz, with the correlation essay and the local sections by Swartz, and finally the descriptive paleontology by Clarke and Swartz. The entire Upper Devonian series in Maryland is divided into a lower marine—the Jennings formation—and an upper non-marine—the Catskill. In the matter of stratigraphy and faunal succession the Maryland Upper Devonian shows a closer relationship with the carefully elaborated Upper Devonian of New York than is as yet known from any other region outside the latter. But even with this close affiliation it has seemed necessary to meet present requirements by interposing new stratigraphic terms. The black shale and peculiar fauna of the Genesee member at the base of this series stand confirmed, but above it the Portage beds with the Naples fauna and the higher Ithaca fauna are embraced by the term "Woodmont shale member." Overlying is the "Parkhead sandstone member" which seems, in place and fauna, to be equivalent to the Enfield member or Unadilla terrane of New York (*Ithaca* in its old and broader sense). The "Chemung sandstone member" has effectively the place and value of the Chemung in New York.

What has been thus said may serve to indicate in small part the purport and presentments of this work. Its collaborators have done honorably and with credit to themselves and their themes in perfecting an encyclopedia of a great geological system in an

important Appalachian field; by means of it correspondences and contrasts with the developments elsewhere of the Appalachian Devonian trough-seas are made more lucid. The writer feels at liberty to speak thus, as he frankly concedes that his part of the book, done ten years ago and laid aside, has been more appropriately attired by the generous labors of Dr. Swartz.

Though the writer's appearance in SCIENCE as reviewer of these volumes is due to the solicitation of its editor, he may take advantage of that fact to express the conviction, which will be shared by all students of the Devonian, that this work is a distinct credit to the science and its accomplishment an added honor to the distinguished head of the Maryland Geological Survey.

JOHN M. CLARKE

Technical Gas and Fuel Analysis. By ALFRED H. WHITE, Professor of Chemical Engineering, University of Michigan. Published by McGraw-Hill Book Company as one of the International Chemical Series. 1913. Pp. 255. $2.00 net.

The book contains seventeen chapters, the first twelve of which deal with gas analysis, the thirteenth with the analysis of liquid fuels, and the remaining four with the analysis of coal.

The methods described in the chapter on the sampling and storage of gases are open to objection in that water is used as the confining liquid. The author carefully emphasizes the fact that the water to be used must be saturated with the gas in question; but changes in temperature and changes in the composition of the gas are sufficient to change the amounts of the various constituents dissolved in the confining liquid. Such changes are to be expected when the gas sampling extends over an appreciable time interval, and render worthless the results of the analysis in the case of certain gas mixtures. There is no objection to using water in sampling gases of low solubility where extremely accurate results are not required, but such a condition does not frequently arise.

No description is given of the apparatus most commonly employed in technical gas analysis at the present time, *i. e.*, the original Hempel apparatus, the author's modification of both the burette and the pipettes being offered in its place. In the opinion of the reviewer, the Hempel apparatus deserves a prominent place in any text-book on gas analysis because of the simplicity of its manipulation and the rapidity with which results that are sufficiently accurate for most technical purposes may be obtained. The slightly greater accuracy obtainable with the White apparatus does not seem to warrant its general use when the longer time and greater inconvenience that are considered.

In the chapter on methods of explosion and combustion, emphasis should have been laid upon the necessity of employing mercury in the burettes that are used with the explosion and combustion pipettes, and in the combustion of methane over copper oxide, on account of the solubility in water of the carbon dioxide that is formed. In this connection, the statement on page 57 concerning the combustion of methane over copper oxide needs revision: "If the gas had been passed back and forth into a pipette filled with water during the combustion there would have been no change in volume, but since the gas was passed into the caustic pipette during the combustion process and the CO_2 was absorbed the contraction equals the methane." A similar sentence also occurs later on the same page.

In the discussion (p. 85) on the combustion of hydrogen, the author criticizes the method of Dennis and Hopkins on the basis of the formation of oxides of nitrogen, on what seems to the reviewer insufficient evidence that was published twelve years ago. He seems to have overlooked the results obtained by Rhodes.[1] These results show that the volume of the oxides of nitrogen that are formed when the combustion is properly performed is always less than .01 c.c., a figure so small as to be negligible.

The author dismisses the subject of the various improved forms of the Orsat apparatus recently placed on the market with a short

[1] Dennis's "Gas Analysis," page 153.

paragraph which closes with the following sentence: "There are decided objections to complication in any form of apparatus which may receive rough treatment in transportation and which is frequently handled carelessly by its operators." It is surprising to note that the author gives preference to a form of apparatus because it is able to withstand "rough treatment" and "careless handling," when it has repeatedly been shown that the apparatus gives erroneous results.

The chapter on exact gas analysis contains a description of two burettes designed by the author. The bulbed gas burette is an improvement over the Pettersson-Hempel gas burette for exact gas analysis with respect to the accuracy with which gas volumes may be read.

Under the methods for the determination of the heating value of a gas, the Junkers calorimeter is taken up in detail, brief mention is made of the Hempel, Graefe, Parr, and Doherty calorimeters, and one paragraph is devoted to the discussion of automatic and recording gas calorimeters. The material in this chapter is excellent. The use of the definition of what is known usually as "total" heating value to define the "gross" heating value is confusing, especially since later in the chapter there is given a table of corrections to obtain the "total" heating value from the observed or "gross" heating value. This chapter also includes a description of the sling psychrometer for determining moisture in air, since the moisture content is one of the variables upon which the value of the above correction depends. The whirling psychrometer is not mentioned.

There is a short chapter on the determination of suspended particles in gas, a subject which has hitherto not been given the prominence it deserves in books of this character. In the words of the author, this is a subject which "is daily becoming of greater importance on account of legal restrictions on pollution of the air and on account of insistence on closer control of industrial operations by manufacturers."

The remainder of the twelve chapters on gas analysis is devoted to a discussion of chimney gas, producer gas, illuminating gas and natural gas, including methods of analysis and the application and interpretation of the results.

The chapter on liquid fuels is short and not so comprehensive as one would expect from the title of the book.

Under coal analysis, there is one chapter on sampling, one on the chemical analysis and two on the determination of the heating value by various methods. Frequent references are made in these chapters to the results of the investigations of the Joint Committee on Coal Analysis of the American Chemical Society and the Society for Testing Materials, of the Bureau of Mines and of the Bureau of Standards.

Typographical errors occur occasionally, *e. g.*, Ernshaw for Earnshaw, page 81, napthalene for naphthalene, pages 164 and 169, and Kjehldahl for Kjeldahl, page 210; there is a lack of punctuation, especially of commas, which renders some of the sentences ambiguous; peculiar constructions are present, *e. g.*, "Chapter II. describes the apparatus which the author believes best adapted to technical gas analysis and gives detailed directions for its manipulation," page 61, and "These gases (sulphur dioxide and sulphur trioxide) are absorbed, oxidized to sulphuric acid and weighed as barium sulphate," page 162; and finally, "estimation" is used throughout the book in place of "determination."

The book is well illustrated; all determinations that involve computations are clearly explained by the aid of concrete examples; and eight useful tables are appended at the close.

R. P. Anderson

Cornell University,
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Professor Noguchi's Researches on Infective Diseases[1]

The Royal Society of Medicine mostly limits the record of its work to its own *Proceedings* and the medical journals; and it does well to observe this wise rule. But from

[1] From *Nature*.

time to time it receives some communication of the highest importance to the general welfare, and on such occasions it is mindful of its immediate duty to the public. It lately held a special meeting, at which Professor Noguchi, of the Rockefeller Institute, demonstrated the results of his researches into syphilis, general paralysis of the insane, epidemic infantile paralysis and rabies. None who heard Professor Noguchi and saw the great crowd of physicians and surgeons listening to him could fail to recognize the profound significance of this occasion.

No man of science works alone or in isolation: and a vast amount of cooperative work is being done in diverse parts of the world on what may be called the "higher types" of germs. Let us note the development of the work. Let us go back half a century, to the earliest methods of Pasteur. We may take 1855 as an approximate date for the beginning of the founding of "the germ-theory." For many years the only method which Pasteur had for the growth of germs in pure culture was the use of fluid media, such as broth; and, under the conditions of bacteriology fifty years ago, the use of these fluid media was full of difficulties. He had to wait until 1872 for the discovery that germs could be grown on solid media, such as gelatine or slices of potato. He had to wait until 1875 for the discovery that germs could be stained with aniline dyes so as to distinguish them, under the microscope, from their surroundings.

Pasteur lived until 1895—that is, ten years after the first use of his protective treatment against rabies, and two years after the first use in practise of diphtheria antitoxin—but he did not live to see more than the beginning of the study of the higher types of germs. At the time when he died, many of the lower types—the bacilli and the micrococci—had been discovered, isolated, grown in pure culture on solid media, and proven, by the inoculation of test animals, to be the very cause of this or that infective disease. But the higher types, such as the *plasmodium* of malaria, were still waiting to be worked out. Then, after Pasteur's death, came Ross's fine work on malaria; and then came two discoveries of no less importance—the discovery (Schaudinn, Hoffmann) of *Spirochæta pallida* in cases of syphilis, and the discovery (Forde, Dutton) of *Trypanosoma gambiense* in a case of sleeping sickness. These two discoveries brought syphilis and sleeping sickness, at last, within the range of practical bacteriology. Long ago, Moxon had said of syphilis that it was "a fever cooled and slowed by time"; but the cause of that fever was unknown until the *Spirochæta pallida* was discovered.

But to prove that it does not merely accompany, but actually causes the disease, it had to be grown in pure culture, and inoculated into test animals, producing in them some characteristic sign. Syphilis must be studied as diphtheria, tetanus, typhoid fever and tubercle had been studied. That is the meaning of all the work done by Ehrlich and his school upon salvarsan—that, in particles of tissue from a rabbit in which the disease has been produced, the *Spirochæta pallida* is present, under the microscope, before a dose of salvarsan, and is absent after it.

The work has been of immeasurable complexity, and there is much still to be done. There are many species of spirochætes discoverable in this or that condition of bodily life, besides *Spirochæta pallida;* indeed, Professor Noguchi demonstrated seven species. But he has cleared the way in this field of bacteriology. He has distinguished those which need some air for their growth from those which can not grow in air; he has discovered the method of adding a fragment of sterilized animal substance to each tube of pure culture: and these methods are of great value.

But that is not all. For he has detected *Spirochæta pallida* in the brain, in general paralysis of the insane. He has found it in twelve out of seventy specimens. There is no need to underline the importance of that statement.

Also, Professor Noguchi has obtained in pure culture the germs of anterior poliomyelitis (epidemic infantile paralysis). Of all the

many diseases of childhood in which the art of medicine, apart from its science, is of no great use, few are more unkind than infantile paralysis. It is the Rockefeller Institute that we must thank here. First came Flexner's magnificent work on epidemic cerebrospinal meningitis, and his discovery (1908) of the special antitoxin for that disease; then came the study of epidemic infantile paralysis. To have in one's hands, in a test-tube, infantile paralysis, is a grand experience for a man who has attended a children's hospital, year in year out, long before the Rockefeller Institute was born or thought of. It is enough to make him believe that the doctors some years hence may be able to stop the disease before it can inflict irremediable injury on the nerve cells of the spinal cord.

Finally, Professor Noguchi spoke of rabies (hydrophobia). He has been able to obtain, in pure culture, the microscopic bodies which Negri discovered in the brain in that disease. He demonstrated to the Royal Society of Medicine, on the lantern-screen, photographs showing the cycle—not unlike that of the *Plasmodium malariæ*—through which these bodies pass until, like miniature shrapnell, they break, setting free their constituent granules; and each granule becomes a "Negri body," and starts the cycle again. Happily, the protective treatment against rabies did not have to wait for the discovery of these Negri bodies. Pasteur worked at rabies, as Reed and Lazear worked at yellow fever, knowing that the virus was there, and able to control, fight and beat it, without seeing it under the microscope.

The Royal Society of Medicine deserves the thanks of the public for inviting Professor Noguchi to give this demonstration in London. He is indeed, in width and originality of work, equal to his fellow-countryman, Professor Kitasato. He has helped to make it possible for men of science to extend to other diseases those methods of study which brought about the discovery of diphtheria antitoxin and the protective treatments against cholera, typhoid fever and plague.

Stephen Paget

DIATOM COLLECTION OF THE UNITED STATES NATIONAL MUSEUM

Dr. Albert Mann, author of the "Report on the Diatoms of the *Albatross* Voyages in the Pacific Ocean" and many other diatom papers, has recently been appointed custodian of the diatom collection of the United States National Museum. This collection already contains much valuable material, including the types of species accumulated by the late Professor H. L. Smith, of Geneva, New York, the specimens of all the species of the *Albatross* diatoms, and the extensive collection of diatom material of the late Professor C. Henry Kain, of Philadelphia, representing the principal fossil deposits throughout the world as well as a large number of recent gatherings made in this country and abroad. To the large amount of material thus brought together, there are being added the marine diatoms of the Shackleton Expedition to the South Pole, diatoms recently secured in the Panama Canal Zone by the Smithsonian Institution, and the pelagic coastal diatoms of the Atlantic seaboard now being collected under the auspices of the Cambridge Zoological Laboratory and the United States Bureau of Fisheries.

For the accommodation of the extensive series of specimens thus assembled a separate room in the National Herbarium has been fitted up with cases, microscope accessories, and other necessary apparatus. The action of the National Museum in thus affording proper facilities for diatom study is in accordance with a growing realization of the importance of these organisms in modern science. Until recently they were appreciated mainly because of their artistic beauty and their interesting microscopical structure. They are now coming to be recognized as constituting one of the fundamental food supplies of the marine world and as having an important bearing on oceanography and recent geology.

Collectors who donate diatom specimens to the National Museum may be assured that their collections will be carefully preserved and made available to diatom students. The number of types already brought together is

sufficiently large to insure a permanent value to this collection, and to warrant an attempt to make it as complete and comprehensive as may be practicable.

FREDERICK V. COVILLE,
Curator of Botany

SPECIAL ARTICLES

REVERSIBILITY IN ARTIFICIAL PARTHENOGENESIS

I

IN 1900 the writer pointed out that in *Campanularia* a highly differentiated organ like the polyp may be transformed into the less differentiated material of the stem, which in turn may form a new polyp.[1] Since then, reversibility of certain phenomena of differentiation has been observed by Driesch, Child, F. Lillie, Schultz and others.

The writer has repeatedly tried to reverse the phenomena of development in the egg of *Strongylocentrotus* fertilized with sperm but thus far without success. Experiments on artificial parthenogenesis, however, gave positive results.

It is difficult to cause artificial parthenogenesis in the eggs of the Californian sea urchin with hypertonic sea water. If we treat these eggs for about 2 or 2½ hours with such a solution (50 c.c. sea water + 8 c.c. 2½ *m* NaCl + $CaCl_2$ + KCl) it often happens that a certain percentage of eggs, after they have been returned to normal sea water, begin to segment regularly in 2, 4 or even 8 or 16 cells. They then stop developing and go into the condition resembling that of a resting egg. If such blastomeres are at any time fertilized with sperm they will develop into larvæ in a perfectly normal way.[2] These observations show incidentally that it is not the lack of the organs of cell division which prevents the unfertilized eggs from developing, since these eggs had been in possession of these organs.

The writer has shown that the induction of development in the egg is due to a combination of at least two agencies. The one causes an alteration of the surface (which may or may not be followed by a membrane formation) and this alteration starts the development of the egg, but leaves it, in many cases at least, in a sickly condition from which it can be freed by the application of the second, corrective agency. The alteration of the surface may be caused by any of those substances or conditions which cause hemolysis: acids, bases, hydrocarbons, hypertonic and hypotonic salt solutions, foreign blood, etc. The second, curative effect may be produced by a short treatment of the egg with a hypertonic solution or by a suppression of the development of the egg for a somewhat longer period by lack of oxygen or by KCN. One method of causing artificial parthenogenesis in the eggs of *Arbacia* consists in putting them for about 20 minutes into a mixture of 50 c.c. *m*/2 (NaCl + KCl + $CaCl_2$) + 0.3 c.c. *N*/10 NH_4OH and subsequently into a neutral hypertonic solution for from 15 to 20 minutes (the figures are given for about 22° C.). A varying percentage of eggs treated this way will develop into embryos and the rest will perish very rapidly. If the eggs are treated with the alkaline solution alone without subsequent treatment with the hypertonic solution they will begin to segment, but they will perish rapidly. The alkaline treatment alone induces the change in the surface of the egg required to start the development, but this, without the corrective treatment, leads only to the first segmentations followed by a rapid disintegration.

The writer found last summer that these effects are reversible in the eggs of *Arbacia*. If, after the treatment with alkaline solution alone or with alkaline and hypertonic solution, the eggs of *Arbacia* are put for a sufficient length of time into sea water containing a certain amount of NaCN or of chloralhydrate, they go back into the resting stage and behave in appearance and reaction like unfertilized eggs. Both the NaCN and the chloralhydrate prevent the developmental processes in the egg. The suppression of these processes of development reverses the changes induced in the egg by the treatment with alkali. If after

[1] *Am. Jour. Physiol.*, IV., 60, 1900.

[2] *Arch. f. Entwicklgsmech.*, XXIII., 479, 1907; *Jour. Exper. Zool.*, XV., 201, 1913.

a sufficient length of time such eggs are removed from the sea water containing NaCN to normal sea water they neither segment nor disintegrate, and if sperm is added they will develop into normal blastulae. If the eggs remain only 20 minutes in the alkaline solution a very short exposure to the NaCN solution suffices. The longer the eggs remain in the alkaline solution the longer they must also remain in the cyanide solution if the effect of the alkaline solution is to be reversed. If they remain too long in the alkaline solution a subsequent treatment of the eggs with NaCN will only temporarily suppress the effects of the alkali, but as soon as they are put back into normal sea water they will disintegrate or develop. In this case the effects of alkali become irreversible.

What has been said for the effects of the alkali is also true for the effects of acid. If we cause artificial membrane formation by butyric acid in the eggs of *Arbacia* (without submitting them to the second treatment) they will begin to develop, but will disintegrate very rapidly. If they are put after the membrane formation for some hours into a cyanide solution they will go back into a resting stage. When transferred to sea water they will neither segment nor disintegrate, and when fertilized by sperm they will develop into normal larvæ.

It is therefore obvious that the induction of development in the egg of *Arbacia* by acid or by alkali is a reversible process.

II

The question arises: Which of the two factors is reversible, the surface change (or its effect in inducing development) or the corrective factor, or both? The experiments show plainly that the first factor is reversible. In this respect the eggs of *Arbacia* differ from those of *Strongylocentrotus*. In the latter the writer succeeded in suppressing temporarily the disintegration following artificial membrane formation by the suppression of development with KCN, but the eggs when put back into normal sea water either developed or perished. There was no such reversion of the induction to development as we find in the egg of *Arbacia*. This difference in the behavior of both kinds of eggs is possibly connected with a difference in the degree and possibly also the character of the alteration of the cortical layer under the influence of butyric acid. This is indicated externally by the difference of the membrane to which the writer had called attention in previous publications. While both types of alterations of the cortical layer induce development, in the egg of *Arbacia* this change is of a degree or character so as to be reversible, while in the egg of *Strongylocentrotus* it is irreversible as far as my present experience goes. When the eggs of *Arbacia* are exposed too long to the alkaline solution the change induced becomes also irreversible.

In the egg of *Strongylocentrotus* the corrective factor is, as the writer has recently shown, irreversible. When eggs, once treated with a hypertonic solution which does not alter them visibly and which leaves them intact, are at any time after one or two days treated with butyric acid, they will not disintegrate, but develop in the same way as if the hypertonic treatment had been applied *after* the membrane formation. I have not yet tried whether or not the same is true for the egg of *Arbacia*.

III

It is impossible to state at present what the nature of the reversible change is. The idea has been expressed by R. Lillie that the inducement of development (membrane formation) consists in a rapid increase of permeability and that the action of the hypertonic solution is to restore a normal condition of permeability in the egg.[3] If this were the case, the simultaneous application of the alkaline and hypertonic solution should leave the egg wholly or nearly intact, while in fact it is just as effective as if we treat the egg first with an alkaline solution and then with a hypertonic solution. Moreover, the hypertonic solution itself induces an alteration of the surface of the egg (membrane formation) which in the terms of this hypothesis would

[3] Lillie, *Jour. of Morphol.*, XXII., 695, 1911.

be interpreted to mean an increase in permeability. Finally, the treatment of the egg of *purpuratus* with a hypertonic solution may precede the artificial membrane formation by one or two days. According to Lillie's hypothesis, NaCN should diminish the permeability of the egg. Direct observations by Wasteneys and myself have shown that NaCN does not influence its permeability.

The reversion of the induction of development is clearly the outcome of the suppression of the developmental changes in the egg by NaCN or by chloralhydrate. During this period of rest the cortical layer may return permanently to a condition resembling that of the normal resting egg. Since fertilization by sperm, artificial membrane formation, and destruction of the egg by cytolysis, all raise the rate of the oxidations in the egg of *purpuratus* by the same amount, the clue to the explanation of the phenomena of reversibility may possibly be found in those conditions of the cortical layer which have to do with the increase in the rate of oxidations after membrane formation.

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SOCIETIES AND ACADEMIES

BIOLOGICAL SOCIETY OF WASHINGTON

THE 414th regular meeting was held in the assembly hall of the Cosmos Club, October 18, 1913, with former President L. O. Howard in the chair and 61 persons present.

The program consisted of three communications:

I. *The Federal Migratory Bird Regulations and their Assistance in the Conservation of Bird Life in America:* T. S. PALMER.

The speaker outlined briefly the history of the Weeks-McLean bill, approved March 4, 1913, and of the adoption of regulations for its enforcement which have been promulgated by the Department of Agriculture under proclamation of the President dated October 1, 1913. Maps of the winter and breeding ranges of some of the species of birds affected were shown, together with another showing the division of the country into two zones. Reasons were given for the exceptions in certain states to the general closed season. In general the beneficial effects upon the bird life of the country expected as a result of the enforcement of the federal law were pointed out.

Hugh Smith and Col. Joseph H. Acklen took part in the discussion which followed.

II. *The Breeding of the Loggerhead Turtle:* W. P. HAY.

The communication was accompanied by lantern slides. It was an account of observations of the habits and reproduction of the diamond-backed terrapin and the loggerhead turtle made at Beaufort, North Carolina. This place is near the northern limit of the distribution of the loggerhead turtle and the speaker was of the opinion that normally in this latitude few of the eggs of the species are left to hatch and that the young from those that may hatch all perish with the first cold weather.

III. *The First Year's Results in Breeding Some Bahama Shells (Cerion) on the Florida Keys:* PAUL BARTSCH.

A former communication by the speaker gave an account of the transfer of two races of *Cerion* from the Bahamas to various Florida Keys. The present paper was an account of observations of the condition of the new colonies at the end of the first year. In general they have prospered and in several localities have reproduced young.

The 515th meeting was held in the hall of the Cosmos Club, November 1, 1913, with President E. W. Nelson in the chair and about 50 members present.

Under the heading "Brief Notes and Exhibition of Specimens," C. Dwight Marsh related an observation in Montana of a noise made by a bull snake (*Pituophis sayi*) which was in close imitation of that made by a rattlesnake. The sounds were made by the respiratory organs and were observed by a number of persons.

The regular program follows.

A. D. Hopkins spoke of Depredations by Forest Insects and their Control. He gave a brief historical sketch of early insect invasions of forests and of the means adopted to combat the pests. The greater part of the paper was devoted to depredations of which the author had personal knowledge. The efficacy of modern methods was pointed out, especially the control work undertaken by the Bureau of Entomology in collaboration with the United States Forest Service. These have been generally adopted by large private holders of timber lands and much saving of valuable timber has resulted.

Paul Bartsch gave an account of the results of dredging for mollusks at Chincoteague, Virginia. In two days collecting eleven new species were found. The speaker gave an account of some personal experiences and observations on the island. He was followed by W. P. Hay, who also spoke of his experiences during a visit to Chincoteague and gave some interesting historical notes of the place.

D. E. Lantz,
Recording Secretary

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

A special meeting of the society was held, October 28, in the National Museum building at 4:30 o'clock.

Dr. Aleš Hrdlička addressed the Society, his subject being "The Results of the Speaker's Recent Trip to Peru; with Remarks on the Anthropological Problems of Peru"; illustrated with lantern slides. In 1910 Dr. Hrdlička made a brief exploratory trip in Peru, which resulted in the acquisition of some valuable data and of important skeletal collections. The opportunity to extend the investigations came during the early part of the current year, in connection with the preparation of the anthropological exhibits for the Panama-California Exposition at San Diego; and as a consequence three busy months were spent on the Peruvian coast and in certain parts of the mountain region of Peru, in exploration of the ruined cities and ancient cemeteries. The principal objects of the trip were, first, the mapping out as far as possible of the anthropological distribution of the prehistoric Peruvian, more particularly the coast people; second, the determination of the physical type of the important Nasca group of people, which represent one of the highest American cultures; third, further inquiry as to man's antiquity on the west coast of South America, and fourth, the extension of the speaker's researches on pre-Columbian pathology. The conclusions to which the speaker was formerly led were in the main corroborated. In regard to the mountain regions much remains to be determined in the future. As to the pathology of the native Peruvian before contact with whites, the main work can perhaps be now regarded as done, or nearly so, although individual variation in different morbid processes seems inexhaustible, and much in this line remains to be secured by future exploration. The ground covered was extensive and the skeletal material examined was enormous, the selections alone filling over thirty boxes. No excavation was practised, attention being restricted, on the coast, to the bones covering the surface of ancient cemeteries, exploited by the peons, and to burial caves and houses in the mountains.

Since the speaker's trip to Peru three years ago, a change for the worse was observed in the state of preservation of the ancient remains. Also, where formerly there were seemingly inexhaustible quantities of skeletal material there is now a dearth of it. No such collection as that made in 1910, when the speaker gathered 3,400 important crania, will ever again be possible from these regions. The major part of the old population of the coast region belongs to the brachycephalic type intimately related to the Maya-Zapotec type in the north. Wherever they lived, these people of the Peruvian coast were wont to practise, more or less, the antero-posterior head deformation. Everywhere along the coast there are evidences of more or less admixture with a more oblong-headed element closely related to the Aztec and Algonquin types of North America. As among the North American Pueblos, nowhere was the aboriginal Peruvian population at any time as great as the relatively numerous cemeteries or ruins might lead one at first to suppose, for these burial grounds and ruins date from different, although not far distant, periods.

The work now done, while to some extent establishing a foundation, is merely a fair beginning. Similar investigations and collections by the anthropologist are urgently needed in the important districts of Piura, Eten and Moquegua, on the coast; in the western sierras from the neighborhood and latitude of Quito to those of Arequipa; and in the eastern highlands from Tiahuanaco to Moyobamba. The most important problems that await solution are (1) the derivation of the Peruvians; (2) the time of their advent into the country; (3) the extension and exact physical characteristics of the Aymara and Quechua, and (4) the genetic relations of the Peruvian to the Argentinan and Chilean aborigines. Besides this there remains to be established in many places the correlation of culture with the physical type of the people. The speaker repeats what he said in a former report, that, due to the lack of scientific supervision of a great majority of the excavations practised in Peru to the present time, the archeological collections from that country are made up of little more than curiosities which it is in most instances impossible to refer either to any definite tribe or period.

Daniel Folkmar,
Secretary